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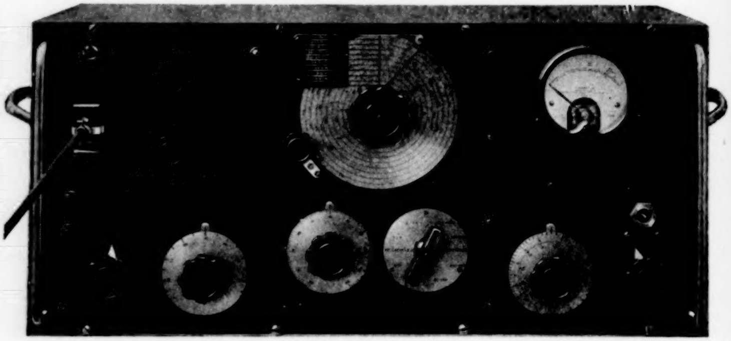

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THE

WIRELESS ENGINEER

VOL. XV. MAY, 1938 No. 176

Editorial

A Faraday Discovery

AN interesting discovery was recently made at the offices of the Royal Society; a sealed letter was found bearing the inscription "Original views—to be deposited (by permission) unopened for the present in the strong box of the Royal Society." This was signed by Faraday and dated March 12th, 1832. Little did he imagine when he wrote that inscription that the letter would remain sealed for over a hundred years. On opening the envelope the following statement was discovered:—

Royal Institution.
March 12th, 1832.

Certain of the results of the investigations which are embodied in the two papers entitled "Experimental Researches in Electricity," lately read to the Royal Society, and the views arising therefrom, in connection with other views and experiments, lead me to believe that magnetic action is progressive, and requires time; i.e., that when a magnet acts upon a distant magnet or piece of iron the influencing cause (which I may for the moment call magnetism) proceeds gradually from the magnetic bodies, and requires time for its transmission, which will probably be found to be very sensible.

I think, also, that I see reason for supposing that electric induction (of tension) is also performed in a similar progressive way.

I am inclined to compare the diffusion of magnetic forces from a magnetic pole, to the vibrations upon the surface of disturbed water, or those of air in the phenomena of sound, i.e., I am inclined to think the vibratory theory will apply to these phenomena, as it does to sound, and most probably to light.

By analogy I think it may possibly apply to the phenomena of induction of electricity of tension also.

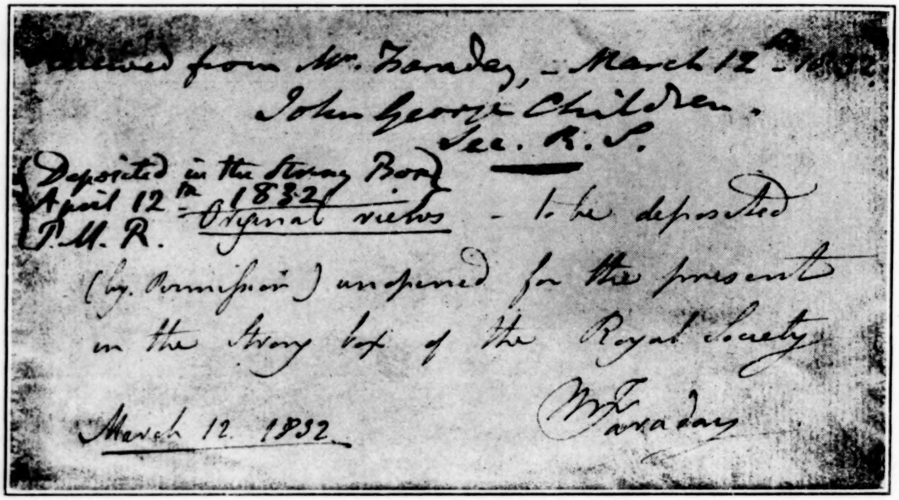
These views I wish to work out experimentally; but as much of my time is engaged in the duties of my office, and as the experiments will therefore be prolonged, and may in their course be subject to the observation of others, I wish, by depositing this paper in the care of the Royal Society, to take possession as it were of a certain date, and so have right, if they are confirmed by experiments, to claim credit for the views at that date; at which time as far as I know no one is conscious of or can claim them but myself.

(Signed) M. FARADAY.

Royal Institution.
March 12, 1832.

Apart from the scientific ideas it is interesting to note the wish to establish priority of conception. The step that he took to ensure this would do credit to the most astute American inventor.

The views which he wished to place on record were that magnetic force and electric forces were probably propagated through space in a vibratory manner at a finite velocity. It should be noticed that there is not the slightest suggestion of any connection between the propagation of electric forces, magnetic forces and light; although he thought that they might all be propagated in a somewhat analogous manner, they were regarded as three entirely distinct phenomena.



eceived from Mr. Faraday, – March 12th 1832.
John George Children.
Sec. R.S.

Deposited in the Strong Box
April 12th 1832
P.M.R.

Original views – to be deposited
(by Permission) unopened for the present
in the Strong box of the Royal Society
March 12. 1832
M. Faraday

Reproduction of the sealed cover with instructions regarding custody of the document.

Vague speculations concerning the propagation of light being due to waves may be traced back to Aristotle, and traces of it can be found in the writings of Leonardo da Vinci and Galileo. In 1665 Hooke spoke of light being due to "a quick vibratile movement of extreme shortness." It had been generally assumed that it would travel with infinite velocity, but Hooke thought that it might be proved to have a finite velocity. It was by adopting an idea which Hooke had expressed in 1672, viz., that the vibrations were transverse and not longitudinal, that Fresnel cleared up the outstanding difficulties of the wave theory of light. Fresnel died in 1827. A Danish astronomer, Römer, had determined the velocity of light in 1676 and his result of 192,000 miles per second was not very far out.

We give this brief historical summary in order to indicate the state of knowledge of the propagation of light at the date of Faraday's letter. One cannot but regret that Faraday did not give a little more information as to the reasons for the views which he expressed. G. W. O. H.

Thermal Stability of Condensers*

Ceramic Dielectrics and Their Use at Low Temperatures

By Philip R. Coursey, B.Sc., M.I.E.E., F.Inst.P.

(Technical Director, Dubilier Condenser Co., Ltd.)

Introduction

THE increasing attention being paid to the applications of shortwave broadcasting, television, etc., is but one reason of several which have led to a much greater attention being paid recently to the stability of radio circuits. With many designs of radio receivers it has been only too common experience to find that the tuning adjustment drifts to quite an appreciable extent as the receiver warms up after switching on. These changes in the frequency to which the circuit is tuned arise from many factors, chief amongst which are the coil and condenser components of the various circuits, although the other components, such as valveholders, etc., connected to these parts frequently also have some appreciable influence.

To increase the thermal stability of both the coil and the condenser components, increasing use is being made of ceramic materials, both to act as rigid mechanical supports which have very small dimensional changes with temperature and also to act as the actual condenser dielectric. Particularly in connection with the latter, there are in practical use a number of different ceramic materials which have markedly different electrical properties. These materials range in dielectric constant from about 7 up to about 90 and in consequence their use has enabled condensers to be produced which provide at least the smaller capacity values in sizes no larger than those heretofore available with say mica dielectric. These ceramic materials cannot, of course, be prepared in the thinness which is commonly employed in the mica sheets used in mica dielectric condensers, but the high dielectric constant of some of the materials more than overbalances this difference.

The range of ceramic materials which is now available covers also a wide range of properties as regards the thermal effects on the capacity of the condenser. The materials having the higher dielectric constants in general have also the larger changes of dielectric constant with change of temperature, while in addition too those same materials have the unusual property of having a negative coefficient of change of capacity with temperature—that is to say, increase in temperature causes a decrease in the capacity of the condenser. With all other ordinary materials, as well as with the ceramic materials of low dielectric constant, increase in temperature increases the capacity of the condenser, while in general also increase in temperature increases also the inductance of the coils in the circuit, both of which lower the circuit frequency as the temperature rises. The use of these ceramic condensers having a negative temperature coefficient of capacity is therefore of importance, as not only does it enable the positive capacity changes of other condensers to be balanced out, but the inductance change also which is of the same sign as the change with other dielectrics, can also be neutralised by appropriate choice of condenser material.

Ceramic materials having dielectric constants of the order of 7 or 8 have small positive temperature coefficients of the order of 100 to 200 parts per million per degree Centigrade, whereas the ceramic materials with the large dielectric constants of 80 to 90 have usually negative temperature coefficients of 600 to 800 parts per million per degree Centigrade.

In between these two extremes there are

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* MS. accepted by the Editor, January, 1938.

a number of ceramic materials known which have intermediate values of dielectric constant and corresponding intermediate values of temperature coefficient. The development and manufacture of these intermediate ceramic bodies, however, is beset with greater difficulties than any of those approaching either of the two extremes, so that the majority of ceramic condensers which are in practical use belong to one or other of the positive or the negative temperature coefficient classes.

Scope of Tests

As indicated above, it is well known that all these ceramic materials possess a high degree of capacity stability and regularity of capacity change with change of temperature at least over the ranges of working temperatures commonly encountered in the use of these condensers in radio receiving apparatus. As, however, applications of condensers sometimes arise wherein they may be needed for use at much lower temperatures, it has been thought of some interest to examine the properties of these materials at much lower temperatures than are commonly encountered in ordinary everyday use. The purpose of this article is to reveal the preliminary results of the investigations in this direction that have so far been made, since these show points of considerable scientific interest. The investigations are, however, by no means yet complete, and as will be seen from the curves given in this article, there is much scope yet for further investigation in order to fill in the gaps in the information which has so far been obtainable and to give in consequence a more complete picture of the behaviour of these materials. These preliminary tests have been confined to a high dielectric constant material as the condenser dielectric, the one chosen being composed of a high proportion of titanium dioxide. It should not be overlooked, however, that the properties of condensers measured in these tests may not represent in every case properties of this material regarded as a dielectric *per se*, since they must to some extent at least be influenced by the actual physical shape as well as the manner in which the dielectric is made up when manufacturing the condenser.

Temperature Stability

In the first place some condensers were investigated for capacity changes when the temperature was lowered from the normal atmospheric room temperature down to that of liquid air, intermediate points being taken by the use of freezing mixtures, solid CO_2, etc. From Fig. 1 it is interesting to note that the linearity of R.F. capacity change with temperature, which is well known over the ordinary atmospheric temperatures, is apparently maintained to a considerable degree of precision down to liquid air temperature. On this diagram two curves are plotted representing the extremes of temperature coefficient of the condensers which were so tested, but in both cases it will be noted that the test observations lie extremely closely on the straight lines drawn in the diagram. The two extreme values of temperature coefficients of the condensers referred to in this diagram work out at 783 and 615 parts per million per degree Centigrade respectively when referred to the capacity of the condensers at a normal reference temperature of 15° C. Referring the capacity changes to the condenser capacities at 0° C., these two coefficients work out at 770 and 608 parts per million per degree Centigrade respectively. The change introduced in the coefficient by changing the reference temperature is of importance particularly when, as in some instances, it is desired to know the temperature coefficient of the condensers to a high

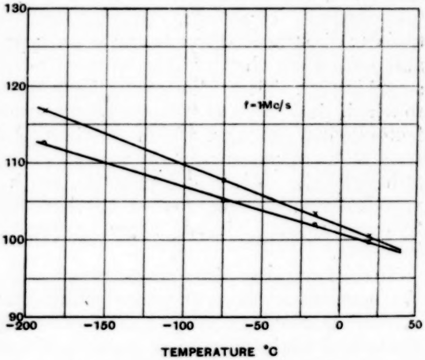

Fig. 1.—*Linearity of thermal characteristic over wide temperature range.*

degree of accuracy, and the difference indicated above emphasises the necessity for definiteness in specifying the conditions to which the coefficient refers. Since for most general practical applications one is concerned with normal room temperatures of 15° to 20° C., it is recommended that one or other of these temperatures should normally be used as a reference temperature when quoting the temperature coefficient, rather than what is, perhaps, the more "scientific" figure of 0° C.

Effect of Frequency

As has already been indicated, the majority of applications of these condensers lie in the radio frequency field, and in that field the capacity of the condensers is almost independent of the frequency of measurement, but it has been known for some time that with many of these condensers and particularly with those using titanium dioxide in the dielectric, there is an appreciable difference of capacity as compared with that measured with an audio frequency bridge at say 1 kc/s. It was therefore thought to be of interest to examine the manner in which the capacity changed at different frequencies and to include also frequencies down to zero. Fig. 2 is typical of the results obtained from such tests. The main part of the curve relates to frequencies between 50 cycles and 1 megacycle per second, and over this part, while there is a definite increase in capacity with falling frequency, the change is not large. The measurement of the capacity of the condensers at zero frequency (D.C.) by ballistic method, however, showed that in general they possessed a very much larger apparent capacity. Under these conditions the shape of the curve between 50 c/s and the D.C. values in Fig. 2 is not known as this region has not yet been investigated, but the enormous change of capacity value as between the two ends of this range indicates the desirability of further investigations in this field. In making the ballistic tests, a comparison method was adopted in order to eliminate as far as possible any difficulties that might be encountered in calibration of the galvanometer, etc., at the low capacity values in which these condensers are normally available. For this purpose a comparison was made between the ballistic throws obtained with the test condenser and from an adjustable air condenser, and the latter was adjusted in each case until the two throws were substantially equal.

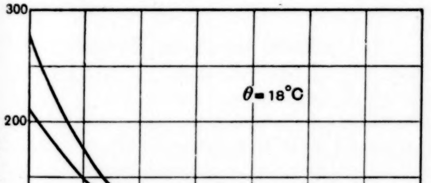

Fig. 2.—*Effect of frequency on permittivity. (The numerical values of the dielectric constant are approximately 85 per cent. of the Capacity Scale.)*

With a material having such a high dielectric constant as the one under investigation, one might expect some anomalous behaviour at certain frequencies—that is to say, if the high dielectric constant is attributable to dipole movements such as is commonly supposed. The curve in Fig. 2 shows, however, that such anomalous behaviour is not experienced over the normal frequency ranges, but whether there is a peak value of capacity between 50 c/s and zero has not yet been determined.

Effects of Temperature and Frequency

If the high dielectric constant indicated by the rise in capacity is due to what one might describe as a type of resonant vibratory movement of the dipoles in the material, one might expect that temperature would also play a part in determining the frequency at which the maximum value of dielectric constant is observed. Fig. 3 shows that this seems to be the case. In this diagram there is plotted the curve for 1 Mc/s, which is linear, in line with the results given in Fig. 1. At 50 c/s, however, a definite hump in the capacity curve is noticed at a temperature around − 75° C., while with D.C. this hump seems to have moved forward to about − 15° C. The exact temperature of the peak of and the precise shape of the whole of this latter curve have not been fully determined and a much more extended investigation at many intermediate temperatures and frequencies would seem to be desirable before this also can be stated completely. The curves of this diagram, however, do perhaps suggest that as the frequency is lowered, the dipoles in the material swing round to an increased extent as compared with what they have time to do under high frequency conditions, and that to permit of the maximum amplitude of movement under the A.C. fields to take place, the temperature must be higher at the lower frequencies. Whether or not this suggestion is merely a fanciful one, further data is needed to decide, but the curious shape of these curves does seem to the writer to suggest some such action.

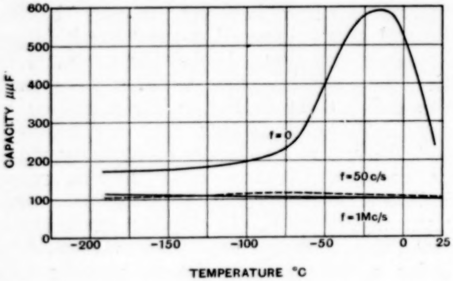

Fig. 3.—*The influence of temperature on the anomalous behaviour at low frequencies.*

In Fig. 4 a wider series of results is plotted in terms of the test frequency, four curves being given for four different temperatures. The curve at normal room temperature marked + 18° C. is shown in the dotted line and has the same characteristics as have already been indicated in Fig. 2. The full line curve is a corresponding test at a temperature of − 17° C. This shows an increase in capacity values over the whole range of frequencies investigated. In the high frequency region this increase amounts to only a few per cent., but the D.C. value has increased nearly three times over its value at room temperature (this, of course, is in agreement with the upper curve in Fig. 3). The chain dotted curve is plotted for a temperature of − 75° C., and this shows a smaller low frequency value, but a definite hummock just below 1,000 c/s; while the dashed line taken at a temperature of − 189° C. shows a still lower D.C. value, but some indications of a hummock in the curve at a frequency above 1 Mc/s. Reviewing these four curves it would seem that the peak of permittivity has moved steadily forward with fall of temperature, until at liquid air temperature it has moved off to a region of several megacycles per second. These four curves enlarge somewhat the picture given by Fig. 3 and seem to the writer to be consistent with the tentative explanation given above in connection with that diagram. The dipolar particles in the dielectric will presumably have some resonant frequency and when the applied testing frequency is near or equal to this value, a maximum amplitude of movement will take place as shown by a rise in apparent dielectric constant. As the material is cooled down the particles presumably become more and more tightly packed together so that their freedom

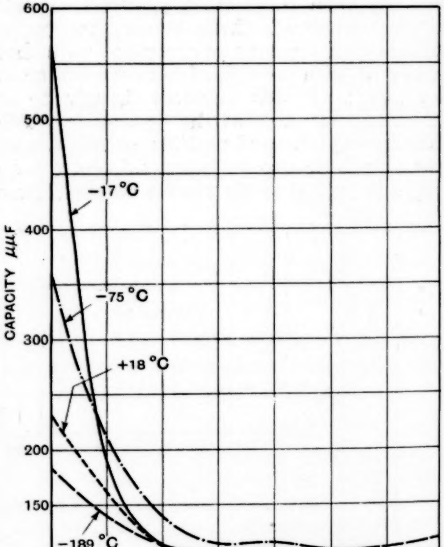

Fig. 4.—*Combined effects of temperature and frequency.*

of movement is much more restricted and in consequence the frequency at which they can move most readily will become higher and higher until, as is seen by the lowest temperature curve, what one may call the average resonant frequency of these particles is over 1 million cycles per second.

Similar remarks apply to this diagram as to those made in connection with Fig. 2, viz., that the exact shape of the curves for the low frequencies below 50 c/s is not known and the general behaviour of them would rather indicate that there should be a maximum of capacity and therefore of dielectric constant below 50 c/s, particularly in the case of the two curves at + 18° and – 17°, since it would appear that a large peak in the latter curve somewhere in the low frequency region has moved forward (and shrunk in amplitude) to around 1000 c/s when the temperature has been lowered to – 75° C. It is probable, therefore, that further investigations will modify considerably the shape of the curves, particularly at the low frequency end of them, and it is hoped that such investigations will be possible at a later date in order to clear up the values of the temperatures corresponding to these peak electrical characteristics, even although such low frequencies are outside the normal range of applications of the condensers.

Effects on Power Factor

The anomalies observed under low temperature and low frequency conditions are further not entirely confined to the dielectric constant of the material. The electrical losses in it seem also to go through a number of unexpected changes. These also require further exploration, but Fig. 5 may be referred to as indicating the magnitude of some of the changes which take place. In this diagram a curve is given of the power factor value of one of these condensers taken at a frequency of 1 Mc/s. This curve shows two peak values; one in the normal atmospheric temperature range at + 10° C. and the other at about — 100° C. Just why these changes occur is not known, but doubtless they will be connected also with the changes observed in the dielectric constant of the material at different temperatures, It will be extremely interesting to enlarge these investigations to include the determination of losses in the material over a wide range of frequencies as well as of temperature, but the technical difficulties of carrying out the measurements at very low frequencies as well as the low temperatures are very considerable, and would entail the development of rather specialised apparatus for the purpose.

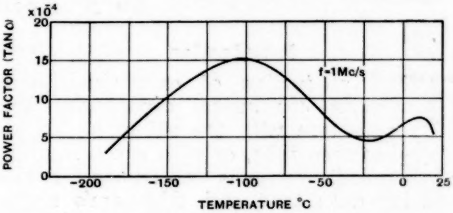

Fig. 5.—*Thermal characteristic of power factor.*

Conclusion

These investigations reported herein are only of a preliminary nature and are given with a dual purpose in view: first, to indicate that the desirable properties of these condensers—viz., their capacity stability and the regularity of their capacity changes with temperature—are maintained over a very wide range of temperatures, provided that they are used at radio frequencies; and secondly, to show that this material possesses some peculiarities of dielectric behaviour, particularly when used at low temperatures and with very low frequencies, and that much further research is still needed to explore this field.

Acknowledgment

The tests of which the curves given herein represent a brief summary, have been carried out in the Research Laboratory of the Dubilier Condenser Company (1925), Limited, London, utilising a number of examples of ceramic dielectric condensers of their manufacture. Since they were made, some further developments have occurred in the technique of the ceramic manufacture which may influence the results. Further tests are therefore in progress, some of the results of which it is hoped may be published at a later date.

Production of Relaxation Oscillations*

Some Experiments with a Soft Triode

By S. Byard, B.Sc.(Eng.)

Introduction

THE production of oscillations in a circuit comprising capacitance and resistance with the aid of an arc or glow-discharge tube, or with a combination of thermionic valves is well known. Hart's flashing neon tube and Abraham's multivibrateur are familiar examples of such circuits. Oscillations may also be maintained in a circuit composed of inductance and resistance with devices such as the dynatron and the back-coupled triode.

B. van der Pol[1] showed that such arrangements are electrical examples of a class of oscillating systems in which the period of the oscillation is determined by the time-constant of the system, and he has given the name "relaxation oscillation" to this kind of vibration. E. Friedlander[2] and K. Steimel[3], among others, have compared the two ways in which these oscillations may be produced.

The following notes describe experiments using a soft triode for the maintenance of both forms of oscillation. The valve employed in the experiments was designed during the war as a detector for wireless reception and is known as the R2A. This valve, which has a cylindrical anode with a concentric helical grid and axial filament, contains helium at a pressure of about 0.6 mm. of mercury. Reference may be made to the papers of Gossling[4] and Stead[5] for details regarding its design.

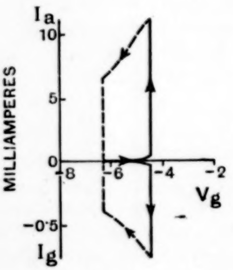

Fig. 1.—*Variation of anode current I_a and grid current I_g with grid voltage V_g, at a fixed anode voltage $V_a = 50$, in the R2A valve. (Filament volts = 4.)*

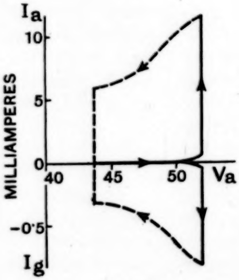

Fig. 2.—*Variation of anode current I_a and grid current I_g with anode voltage V_a, at a fixed grid-bias $V_g = -5$, in the R2A valve. (Filament volts = 4.)*

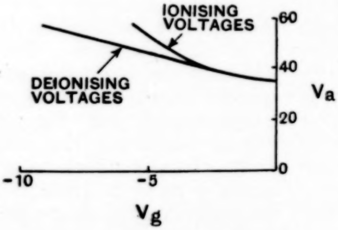

Fig. 3.—*Values of grid voltage V_g and anode voltage V_a, at which ionisation and deionisation set in. (Filament volts = 4.)*

Characteristics of the Gas-filled Triode

If a potential considerably higher than that required to ionise the gas within the valve (21V. in this case) be applied to the anode, and if then the negative bias on the grid be reduced, a point will be reached where the anode current suddenly grows in value from a very small amount to several milliamperes. This discontinuity results from a cumulative ionisation in the anode-grid space of the valve; the positive ions are attracted to and through the grid, neutralising the effect of its potential and at the same time reducing the space-charge, thus enabling more electrons to act in the anode-grid space. Increase in negative grid-bias, or a decrease in the anode voltage results in a sudden deionisation, but this sets in at a lower value of anode voltage, or at a greater negative grid-bias than that at which ionisation takes place. The pres-

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* MS. accepted by the Editor, July, 1937.

ence of this "hysteresis" effect, as it has been called, made the valve somewhat difficult to operate in a wireless receiver. In the modern thyratron the grid loses all control, and deionisation can only be effected by reducing the anode voltage.

The full lines in Fig. 1 indicate the sudden growth of anode current and of grid current when the anode voltage is fixed at 50 V. and the negative grid-bias is reduced from − 8 to −4.5 V. The broken lines on the same figure show the value of the anode and grid currents as the bias is increased from −4.5 to −8 V., deionisation taking place at − 6.4 V. There is here a difference of 1.9 V. between the ionising and the deionising voltages. Similar characteristics may be obtained for the case where the grid voltage is at a fixed negative value and the anode voltage is varied. In Fig. 2 the grid-bias is fixed at − 5 V., and ionisation and deionisation occur at anode voltages of 52 and 43.6 V. respectively, the difference amounting to 8.4 V.

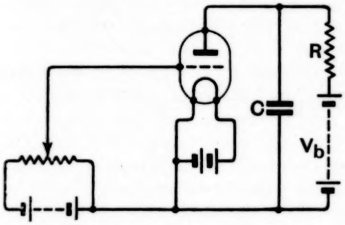

Fig. 4.—*Circuit for the maintenance of relaxation oscillations, with a shunt condenser and series resistance in the anode circuit.*

The magnitude of this difference between the ionising and deionising voltages of an electrode depends upon the voltage applied to the other electrode. This is illustrated in Fig. 3, which was obtained by plotting the values of grid-bias at which ionisation and deionisation occurred with different fixed values of anode voltage. When the anode potential is less than 40 V. ionisation and deionisation set in at substantially the same value of grid voltage, but with, for example, 60 V. on the anode the valve ionises when the negative grid-bias is reduced to − 6 V., and does not deionise until this bias is increased to − 10.4 V. A chart constructed by fixing the grid-bias at various values and plotting the values of anode voltage at which the valve ionised and de-ionised gave very similar curves.

Maintenance of Oscillations in a Circuit Comprising Capacitance and Resistance

It will be apparent that the valve can be used in place of the neon tube in Hart's circuit[6] in the manner depicted in Fig. 4. In both cases the periodicity of the discharge of the condenser through the ionised tube, with given circuit conditions, depends upon the difference between the ionising and de-ionising voltages. An important difference between the operation of these two devices is that, whereas in the neon tube these voltages are fixed, they are a function of the grid potential in the soft triode and Fig. 3 indicates, as experiment shows, that with fixed values of anode battery voltage, series resistance, and capacitance in shunt with the valve, variation of the flashing periodicity may be obtained by varying the grid-bias, the frequency increasing with decrease in negative bias. A further difference lies in the fact that the triode is a hot-cathode device and ionisation takes place at quite low voltages. Relaxation oscillators employing valves of the thyratron type have often been described, and P. Drewell[7] has studied their behaviour and advocated hydrogen as a filling in order to increase the frequency range.

Curve A of Fig. 5 shows the change in frequency of the oscillations obtained by varying the grid-bias. In this particular case the battery voltage was 58 V., the series resistance 3,600Ω, and the shunt condenser 0.3μF. Oscillations began at a frequency of about 200 c/s when the grid-bias was reduced to − 5.6 V., and the frequency increased smoothly with further reduction of bias

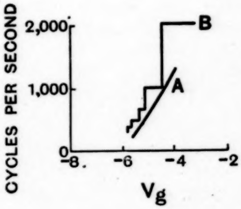

Fig. 5.—*Variation of the frequency of the oscillations with grid-bias V_g, in a circuit such as that indicated in Fig. 4 (where $R = 3{,}600\Omega$; $C = 0.3\mu F.$; $V_b = 58$). Curve A.—Normal variation of frequency. Curve B.—Variation of frequency when an alternating e.m.f. (2,000 c/s) is present in the grid circuit.*

reaching a maximum of 1,250 c/s with — 3.8 V. on the grid, at which point the oscillations ceased. In the oscillating range the mean anode current increased from 0.2 mA. with — 5.6 V. on the grid to 4.2 mA. at — 3.8 V. grid-bias. The frequency range could be varied in the usual manner by altering the values of resistance, capacitance, and battery voltage.

Production and Selection of Sub-harmonics of an Impressed Tone

Sub-harmonics, or the frequency division of an impressed tone may be obtained with this circuit in a manner similar to that described by van der Pol and van der Mark[8], who used a neon tube oscillator. The alternating voltage may be applied directly in series with the anode of the valve, or, preferably, injected into the grid circuit.

An alternating voltage of quite a small amplitude will then control, within certain limits, the frequency of the relaxation oscillations in the anode circuit, since the most favourable time for ionisation will occur during a positive peak of the applied voltage, and the anode circuit oscillations will fall into step, having a frequency equal to, or some harmonic fraction of the frequency of the impressed voltage. The stepped line *B* in Fig. 5 shows how the frequency of the relaxation oscillations jumps from one fraction to another as the grid-bias is varied. A similar discontinuous progression is observed when either the capacity or the resistance is varied. The sub-harmonic obtained also depends upon the amplitude of the applied voltage.

Preferential selection of one sub-harmonic may be realised either by introducing a resonant network into the anode circuit or by providing a selective feed-back between the anode and grid circuits. The first method employs the principle illustrated by the experiments of W.H. Eccles and W. A. Leyshon[9], where the frequency of a flashing neon tube was controlled by a mechanical resonator. The action in both cases is such that oscillations are most favourably maintained in the neighbourhood of the resonance frequency.

Fig. 6 shows a circuit arrangement for selective feed-back which has been tried. L_1 and L_2 were multilayered air-cored coils closely coupled to one another. The inductance of the anode coil L_2 was 20 mH., and that of the grid coil 120 mH. The grid coil was shunted by a condenser C_1 of 0.3μF., so that effective feed-back could only occur with frequencies close to the resonant frequency of the parallel circuit L_1C_1, that is, in the neighbourhood of 840 c/s. The first test, in which the controlling voltage was absent, showed that with alteration of grid-bias, a smooth variation in the frequency of the oscillations ensued, as has been described above, but that when the frequency of the discharge was near that of the resonant circuit the rate of change of frequency with variation of grid-bias became very small over a considerable range of the latter. On introducing a controlling voltage with a frequency of about 2,520 c/s (that is, three times the resonant frequency of the feed-back), the stepped frequency appeared, and, as was expected, the third sub-harmonic was maintained over a much larger range of grid potential than was possible with the circuit without selective feed-back.

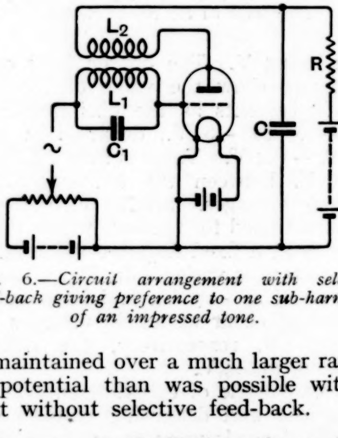

Fig. 6.—*Circuit arrangement with selective feed-back giving preference to one sub-harmonic of an impressed tone.*

Maintenance of Oscillations in a Circuit Comprising Inductance and Resistance

In the production of oscillations in an inductive circuit use is made of the "negative-resistance" characteristic of the grid circuit. A good many years ago it was proposed[10] to use this property in the maintenance of high-frequency oscillations in a parallel-resonance net in series with the grid circuit. Oscillations produced in this way will be sinusoidal, with a frequency determined by the product of the inductance and the capacitance of the circuit.

When the potential on the grid of a soft triode is varied from positive to negative through zero, the grid current is found to fall to zero and then to reverse, reaching a maximum and again decreasing to zero with increasing negative bias. The reversal and increase of the grid current shows that positive ions are being collected by the grid more rapidly than electrons, and the fall which occurs with a further increase of negative bias (this is the negative-resistance portion of the characteristic), results from a decrease in the number of positive ions, since there are fewer fast electrons in the anode-grid space available for their production. With anode voltages considerably higher than the ionising potential this grid current characteristic is not continuous, since a cumulative ionisation takes place.

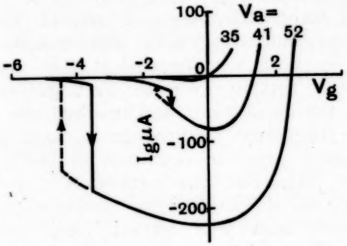

Fig. 7.—*Grid current* (I_g)/*grid voltage* (V_g) *characteristics of the R2A.* (*Filament volts* = 3·75.)

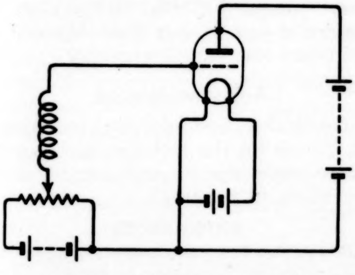

Fig. 8.—*Circuit for the maintenance of relaxation oscillations with an inductance in the grid circuit.*

Fig. 7 shows the grid current characteristics for different values of anode voltage. The characteristic with an anode potential of 35 V. is perfectly regular over the range considered and a low maximum of $-5\ \mu$A. is reached with a grid-bias of $-$ 0.5 V. With higher anode voltages the discontinuity due to ionisation becomes apparent. Thus, with 52 V. on the anode, starting from a high negative grid-bias, the grid current increases smoothly from zero to $-$ 10 μA. as the bias is reduced to $-$ 3.6 V., at which point the grid current suddenly jumps to $-$ 170 μA. and then continues to increase smoothly with decreasing negative bias, reaching a maximum of $-$ 230 μA. at zero bias, and finally decreasing as positive bias is applied.

Relaxation oscillations may be maintained merely by inserting an inductance in the grid circuit as in Fig. 8, and by operating the valve with an anode voltage greater than 40 V., biassing the grid to a point on the falling characteristic. The oscillations produced with large iron-cored inductances have very marked peculiarities. The waveforms of the oscillations obtained with a 5 H. choke are sketched in Fig. 9 (a) to (d), as observed on a cathode-ray oscillograph with a linear time base. The waveforms of the anode and grid currents were obtained by utilising the potentials, suitably amplified, which were developed across non-inductive resistances inserted in the anode and grid circuits. The most striking feature of the oscillation is the periodic excursion of the grid potential to some 40 V. negative, with the consequent complete suppression of

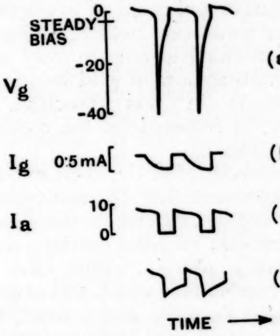

Fig. 9.—*Waveforms of the oscillation produced with the inductive grid circuit.* (L = 5 *H.*). (*a*) *Potential difference between grid and negative end of filament.* (*b*) *Grid current, mA.* (*c*) *Anode current, mA.* (*d*) *Grid potential when the inductance is shunted by a resistance of* 100,000Ω.

anode current. With chokes larger than 5 H. this negative excursion is considerably greater, and occupies a smaller portion of the complete period.

Some idea of the mechanism involved in the production of this form of vibration may be obtained from the following elementary consideration. Let it be supposed that at some instant the grid current is decreasing. This decrease induces a back e.m.f. in the inductance in such a direction as to increase the negative bias on the grid of the valve, which implies a still greater decrease in the grid current. This process continues until the valve deionises when the sudden decrease in grid current to zero induces a very large voltage, making the grid extremely negative. This large negative potential can only be maintained by the decreasing grid current, and the subsequent loss of negative potential is accelerated by the sudden ionisation which, inducing an e.m.f., makes the grid momentarily positive, but the resulting flow of grid current limits the amplitude in this direction. These effects may be followed on the oscillograms (*a*) to (*c*) in Fig. 9.

It will be recognised that this explanation is incomplete, and that the self-capacitance of the circuit must determine the time taken for the excursion into the extreme negative, and limit its amplitude. With large chokes having a reasonably small self-capacitance this excursion occupies but a small fraction of the total period, and the frequency of the oscillation is determined by the inductance and resistance of the circuit. If, however, the shunt capacitance is purposely increased, the oscillations rapidly approach the sinusoidal form and have a relatively small amplitude. This condition was realised with the experimental apparatus when the 5 H. choke was shunted by a condenser of capacitance 0.05 μF. Fig. 9 (d) shows the grid voltage waveform when the choke was shunted by a resistance of 100,000Ω. This resistance increased the frequency of the oscillations, and reduced the amplitude of the negative peaks.

The frequency increases to a maximum with increasing negative grid-bias. The exact limits over which oscillations may be maintained and the range of frequency depend upon the anode voltage, the filament temperature, and the size of the choke. With the 5 H. choke the frequency could be varied between about 1,500 c/s and a few hundred c/s. With a larger choke the range was from about 500 c/s to 2 or 3 c/s. Using an air-cored inductance of 0.07 H. the frequency could be varied between 50 kc/s and 28 kc/s by decreasing the negative bias. A further increase in negative bias when the oscillations had reached the maximum frequency resulted in a rapid fall in frequency prior to cessation of the oscillations. Thus, in one experiment, the frequency of the oscillations increased as the negative bias was varied from zero to $-$ 3.2 V., and then decreased with further increase of the bias to $-$ 3.9 V. at which point the oscillation ceased. The oscillations characterised by a decrease in frequency with increasing negative grid potential, as distinct from those which increase in frequency, appear to be produced when the grid-bias is located between the two points at which ionisation and deionisation set in.

In common with other forms of relaxation oscillators sub-harmonics may be obtained by introducing a controlling potential into the circuit. In some early experiments an incompletely smoothed rectifier working off the supply mains was used in place of the battery in the anode circuit. A series of discrete jumps in the frequency (sub-harmonics of 50 c/s), was then obtained when the grid-bias was varied smoothly.

Acknowledgment

In conclusion I would like to thank Dr. W. H. Eccles for the facilities he has granted for these experiments, and for the interest he has taken in the work.

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A New Modulation Meter[*]

By F. C. Williams, M.Sc., D.Phil., and A. E. Chester, B.Sc.

(Manchester University)

I. Introduction

THE conditions to be fulfilled by a successful modulation meter have been summarised by Gaudernack[1] as follows :—

(1) The instrument must respond to peak values of modulation depth.

(2) " Crest " and " Trough " values of modulation depth should be separately meaurable.

(3) The calibration should be independent of the modulation frequency when the modulation is sinusoidal : this is implicit in (1), the extent to which it can be attained is discussed later.

(4) The meter should be direct reading ; that is, some pointer should indicate directly the measured depth.

(5) The instrument should be self-contained and operated from the a.c. mains.

(6) The accuracy should be within a few per cent.

(7) The H.F. energy absorbed should be as small as possible : this is especially necessary for laboratory work where small signals are used.

To these the authors would add :—

(8) The meter should be robust and inexpensive.

The meters of Strafford[2], Lovell Foot[3], and Cooper and Smith[4], do not fulfil these requirements as they measure either R.M.S. or arithmetic mean values of modulation depth ; and thus can only measure peak modulation depths for known waveforms. Gaudernack developed the instrument shown in Fig. 1. In this the meter M_1 measures the peak value of the carrier voltage, and meter M_2 measures the peak value of the modulation as developed across R. In order that M_2 should register the true peak value of the modulation voltage, the input impedance of the second peak voltmeter must be high : a value of $R_1/R > 100$ appears desirable[†]. Further, an upper limit is set to the value of R_1 by the sensitivity of meter M_2, and Gaudernack adopted 8,000 ohms as a suitable value for R. With the carrier input voltage set to the value at which the meter was calibrated[‡] the input energy was about one watt.

It follows that meters based on Fig. 1 must infringe either requirement (7) or (8) above ; for with a given carrier input voltage either R must be made low and infringe (7), or R_1 made high and infringe (8), since the second meter must then be highly sensitive and will be neither robust nor inexpensive. It may be noted also that a lower limit for R is set by the slope resistance of the first diode, *vide* Marique[5]. This is of particular importance if the meter is to be used on short wavelengths, for the first diode must then be as small as possible to avoid excessive capacitance.

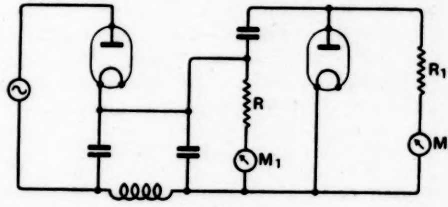

Fig. 1.

The meter described in the present paper

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[*] MS. accepted by the Editor November, 1937.

[†] The second peak voltmeter is in effect supplied with current which must traverse the resistance R : R can therefore be added to the slope resistance of the second diode in estimating the performance of the second peak rectifier. Marique[5] has discussed the dependence of peak rectifier performance on the ratio $\left(\frac{\text{load resistance}}{\text{valve slope resistance}}\right)$ and the present statement is based on his findings.

[‡] The instrument is direct reading for one value of carrier input voltage only, meter M_1 being set to a stated value before each measurement.

has been designed to avoid these disadvantages and to fulfil the requirements (1)—(8) as fully as possible.

II. Principle of the New Meter

The meter takes slightly different forms according as " crest " or " trough " modulation depths are to be measured : these forms will first be described separately. The basic circuit of the " trough " meter is shown in Fig. 2.

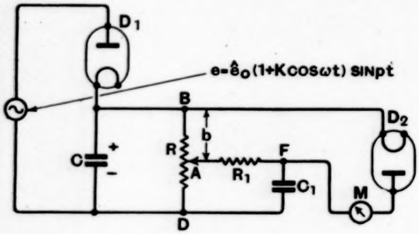

Fig. 2.

D_1, R, C, R_1 and C_1 constitute a diode peak rectifier in which provision is made for separating the direct and alternating components of an adjustable fraction of the output voltage. Such rectifiers are in common use in radio receivers and their mode of operation is well-known. Thus, if a modulated wave $e = \hat{e}_0\ (1 + K\ \cos \omega t)\ \sin pt$ is applied, as shown in the figure, there results across BD a $P.D.$ given very closely by

$$V_{BD} = \hat{e}_0(1 + K \cos \omega t) \quad .. \quad .. \quad (1)$$

provided certain conditions to be discussed later are satisfied. If now b is the resistance from A to B expressed as a fraction of R, and if R_1C_1 is $\gg 2\pi/\omega$ and $R_1 \gg R$, then there will exist across FD a sensibly steady P.D. given by

$$V_{FD} = (1 - b)\hat{e}_0 \quad .. \quad .. \quad (2)$$

The condition that D_2 shall never conduct can be stated as

$$V_{FD} < V_{BD}$$

or $(1 - b) < (1 + K \cos \omega t)$ from (1) and (2).

It follows that if b is first set $= 1$ and then gradually reduced, conduction will not occur until

$$1 - b = 1 - K$$

such conduction occurring in pulses whenever $\cos \omega t = -1$: that is, at the " trough " of the modulation curve. Hence if R is calibrated for b, and b is decreased from unity until the meter M registers a small deflection then

$$K_{\text{trough}} = b.$$

The circuit of the " crest " meter is shown in Fig. 3.

In this circuit a second resistance R is connected in series with the calibrated potentiometer. It follows from the circuit of Fig. 3 and the discussion of Fig. 2 that now

$$V_{BD} = \hat{e}_0(1 + K \cos \omega t)/2 \quad .. \quad (3)$$

provided $R_1 \gg R$.

And $V_{FD} = \hat{e}_0(1 + b)/2 \quad .. \quad .. \quad (4)$

The diode D_2 having been reversed the condition for no conduction is now

$$V_{FD} > V_{BD}$$

or $\quad 1 + b > 1 + K \cos \omega t.$

Hence, as before, if b is set equal to 1 and then reduced pulse conduction first occurs when

$$1 + b = 1 + K$$

that is, whenever $\cos \omega t = +1$, and if as before R is calibrated for b,

$$K_{\text{crest}} = b.$$

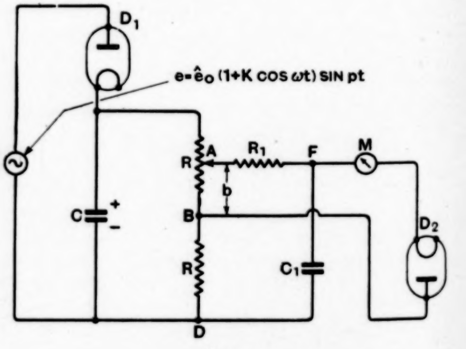

Fig. 3.

In the foregoing description, a sinusoidal modulation has been considered : this form was adopted for convenience only, and it is self-evident that the results refer equally well to non-sinusoidal forms.

III. Practical Form of Meter

In applying the principles of the previous section to a practical meter, it is first necessary to replace the sensitive meter M by some more robust device. The circuit of the device adopted is shown in Fig. 4.

The meter M registers the mean value of the current pulses flowing in the anode circuit of the triode. A small steady negative bias is applied to the grid by the self bias resistance R_4 shunted by a large electrolytic condenser C_4. This bias is introduced to prevent the flow of grid current which would bias the diode D_2. So long as p remains negative with respect to q, the diode D will not conduct, and hence no bias will be applied to the grid of the triode. Whenever p swings positive with respect to q the peak rectifier D, R_2, C_2, records the extent of such positive swing, and applies a steady positive voltage to the grid of the triode. M records the corresponding increase in anode current. R_5 is introduced to limit the possible positive excursion of the grid and so to avoid damage to M. This device can replace the diode D_2 of Fig. 3, and with the components actually used corresponds with a meter in that circuit responding to a small fraction of a microampere.

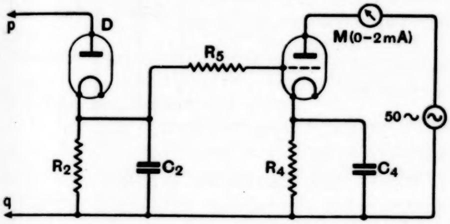

Fig. 4.

The diode D_2 of Fig. 2 can be replaced by a similar device to that of Fig. 4, except that the diode D is reversed. The deflection of M then shows a decrease when the potential of p swings below that of q.

It may be noted here that the milliammeter is completely protected from accidental overloads; in one connection overloading merely reduces the deflection to zero; in the other R_5 of Fig. 4 prevents the grid becoming appreciably positive with respect to the cathode, accordingly if the zero bias current traversing the triode is arranged to lie within the range of M dangerously high deflections are prevented.

A practical meter must embody both the forms discussed in the previous section. The switching arrangement necessary for the change over is shown in Fig. 5.

With the switch in the "crest" position the circuit corresponds exactly with that of Fig. 3, with the modification just described. With the switch in the "trough" position there is a modification of Fig. 2, in that a fixed resistance R is introduced in series with the potentiometer: the mode of operation is not affected by R, however, which is merely retained with the object of simplifying the switching arrangement.

Although the calibration of the meter as discussed so far does not depend on the magnitude of the input voltage, a certain minimum voltage is required to ensure true peak rectifier action in D_1, and to permit the neglect of emission energy currents and contact P.D. in the diode D_2. A suitable minimum is 20V. Further, an upper limit of input voltage is set by the reverse voltage which D_1 will withstand; a suitable maximum is 100V.

In order to facilitate the input being set between these limits, a switch is arranged to connect the meter in series with a 50,000 ohm resistance loading D_1. The meter then records carrier input voltage from 0–100V. It may be noted that, due to the reversing of the diode D_2 when switching from the "crest" to the "trough" position, the meter M registers an increase in current when recording "crest" modulation, and a decrease in current when recording "trough" modulation.

A further departure from the original simple circuits has been made: a radio frequency choke has been included in the first rectifier output circuit. It is included with the object of preventing the flow of H.F. currents in the load circuit. It exerts a negligible effect on the modulation frequency response of the rectifier. With the same object in view, the carrier frequency and modulation frequency portions of the apparatus were screened from each other. The overall screening was such that the apparatus could be operated successfully within a few feet of a powerful short wave transmitter.

The values of the components used in an

experimental model are shown in Fig. 5: these values are by no means rigid, their proper choice to suit individual requirements is discussed in the next section.

IV. The Choice of Component Values

The theory of the present meter, and of all diode meters, depends on the attainment of distortionless rectification by the first rectifier. In the present meter the load imposed by the second diode under operating conditions is entirely negligible, the circuit to be considered is therefore that of Fig. 6. The figure refers to the " crest " connection.

The conditions necessary to the distortionless operation of this circuit have been fully discussed in a paper by Roberts and Williams[6] and need but brief consideration here. To ensure true peak operation of the rectifier, the time constant of the load circuit must be long compared with the periodic time of the carrier wave: the limitation suggested was

$$2CR \nless 20\pi/P \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

Further, $2R$ must greatly exceed the slope resistance of the diode ρ, say

$$2R \nless 100\rho \quad \ldots \quad (6)$$

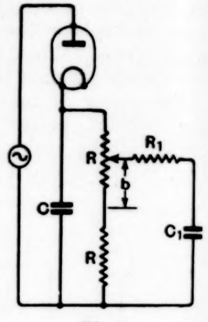

Fig. 6.

Also to assist in the elimination of H.F. components in the rectifier output, we require

$$C \nless 10\,C_d \quad \ldots \quad (7)$$

where C_d is the diode self-capacitance.

To these may be added that stated in section II

$$R_1 \gg 2R$$

say $R_1 \nless 40R$ .. (8)

With these conditions satisfied the paper showed that the voltage developed across the diode load resistance $2R$ would be an undistorted copy of the input peak values provided

$$1/\alpha^2k^2 \geqslant \beta^2 + T^2\omega^2 \quad \ldots \quad \ldots \quad (9)$$

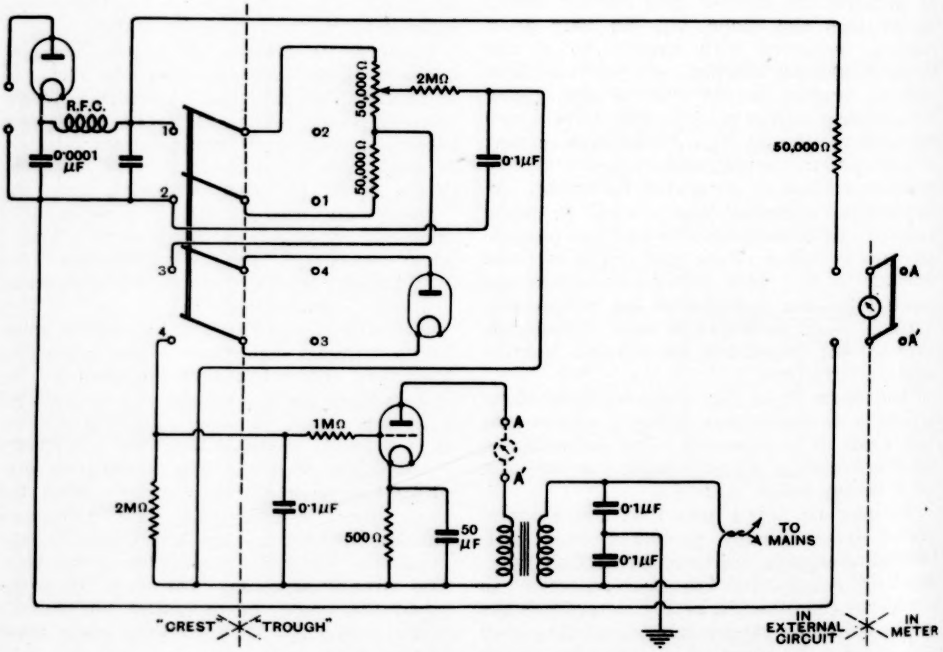

Fig. 5.—*The circuit for practical form of meter. Terminals enumerated similarly are interconnected.*

where :—

k = modulation depth.
ω = highest component frequency of the modulation.
α = unity in the present circuit and does not concern this analysis.
$T = 2RC$

$$\beta = \frac{(1 + b)R + R_1}{R_1 + R(1 - b^2)/2}$$
$$= \frac{1 + (1 + b)R/R_1}{1 + (1 - b^2)R/2R_1}$$

Since b varies only between 0 and 1, and since R/R_1 is of the order of 1/40 at the most, β differs but little from unity.

If " trough " modulation is being measured it is merely necessary to change the sign of b in the above formulae ; β again approximates to unity.

Condition (9) can therefore be written approximately as

$$2RC \leqslant \frac{\sqrt{1 - k^2}}{k} \cdot \frac{1}{\omega} \quad \ldots \quad \ldots \quad (10)$$

Requirements (5), (6) and (7) will indicate a minimum permissible value for $2RC$ in any given case : condition (10) demands that this minimum value should be approached if the scope of the instrument as regards maximum modulation frequency and depth is to be greatest. The conditions (5), (6) (7) and (10) are mutually dependent, and their satisfaction in particular cases must be a matter of compromise : it is discussed more fully in the paper already quoted. The values chosen in the experimental model were regarded as suitable for carrier frequencies of 100 kc/s upwards, and modulation frequencies up to 10 kc/s. When higher carrier frequencies are postulated a reduction in C is permissible, but stray capacities together with the satisfaction of (7) set a lower limit to C of about 20$\mu\mu$F. R might reasonably be reduced to half the present value without resorting to a larger first diode. Such modifications would yield an equal performance with modulation frequencies up to 200 kc/s, see equation (10).

When condition (10) is infringed, Roberts and Williams showed that the mean voltage developed across R is greater than the carrier peak value, and that the " trough " value of the voltage across R is then greater than the " trough " value of the input signal.

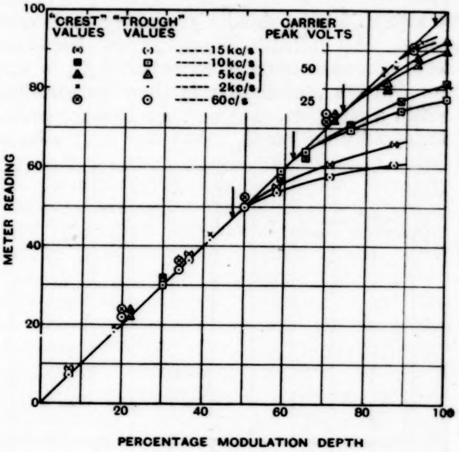

Fig. 7.

It follows that infringement of (10) leads to low readings on the meter for both " trough " and " crest " values : the effect being more pronounced in the case of " trough " values. Curves illustrating this effect, and which relate to the experimental model, are shown in Fig. 7. Here recorded modulation depth is plotted against true modulation depth for various modulation frequencies. The modulation frequencies used were 15 kc/s, 10 kc/s, 5 kc/s and 2 kc/s with the carrier peak input voltage of 50, also 60 c/s with carrier peak input of 25 volts. The curves to which each frequency is relevant are indicated in the figure. It may be seen that the instrument is accurate within a few per cent. with frequencies from 60 c/s to 2,000 c/s, over the whole range. At 5, 10, and 15 kc/s, however, the meter reads low above a certain modulation depth as indicated by (10) and the foregoing discussion. The arrows indicate the various values of K above which (10) is infringed; these may be seen to correspond closely with the observed departure of the higher frequency curves from the calibration. The ease and accuracy with which the meter can be set is illustrated by Fig. 8, which shows the milliammeter reading as a function of the setting of the potentiometer. The input was 25 volts carrier and was modulated 51 per cent. at 1,000 c/s. The instrument was calibrated with 50 volts carrier input allowing a change of deflection of 0.02 mA's. The curves of Fig. 8 show that this change need be accurately set only when high precision is required.

The performance of the meter with low modulation frequencies has not yet been discussed: it was assumed in section II, however, that

$$R_1C_1 \gg 2\pi/\omega$$

and this condition must be satisfied for the lowest modulation frequency. If R_1C_1 is made too great the potentiometer has to be adjusted very slowly in making measurements. A suitable compromise between these considerations is to make $R_1C_1 = 0.2$ sec. 50 c/s modulation is then measurable within a few per cent., and the balance point can rapidly be found.

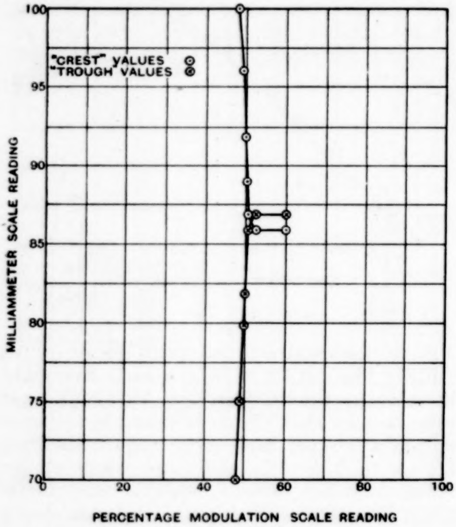

Fig. 8.

Similar considerations determine R_2C_2 ($= 0.2$ sec.), and it may be noted that in the interests of sensitivity R_2 should not be less than R_1.

V. Conclusion

The meter which has been described is felt to fulfil the requirements set out in the introduction more fully than earlier meters. Especially is this true when (7) and (8) are important considerations. It might appear that requirement (4) . . . the meter should be direct reading . . . has not been fulfilled in that an adjustment is necessary in performing the measurement. In fact, some such adjustment is necessary in all so-called "direct reading" modulation meters, for in all earlier types the carrier input must first be set accurately to the value obtaining during calibration.

Apart from the normal application of measuring modulation depths, the instrument can be of assistance in the lining up of apparatus. For if pure tone modulations are used the instrument will record the degree of distortion as a difference of "crest" and "trough" readings. Further, on programme modulations the meter can be preset to a chosen value of modulation depth; the "kicking" of the milliammeter will then record the occurrence of modulation depths in excess of the chosen value.

The meter, which has been patented, was developed in the Electro-technical Department of Manchester University, and the authors are indebted to Professor R. Beattie for the facilities placed at their disposal. Its manufacture has been undertaken by the Metropolitan-Vickers Co.

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6. *Journal I.E.E.*, Sept., 1934.

The Industry

FERRANTI announces that, due to the higher cost of labour and materials, it has been necessary to increase the price of small ammeters and voltmeters. A new price list is available.

Marconi-Ekco Instruments, Ltd., of Electra House, Victoria Embankment, London, W.C.2, has issued a leaflet giving a specification of the new Type TF430 Signal Generator.

The appropriate types of rotary converter to use with various well-known broadcast receivers are shown in a new edition of the catalogue issued by the Electro Dynamic Construction Company, St. Mary Cray, Kent.

A prospectus of the Phœnix Radio Engineering Library is issued by The Phœnix Book Company, 66, Chandos Street, Charing Cross, London, W.C.2.

Losses in Ferromagnetic Laminae at Radio Frequencies*

By M. Reed, Ph.D., M.Sc., A.M.I.E.E.

IN a Radio Research Report published in 1934[1] †, Colebrook gave a summary of the knowledge available up to that time of the behaviour of magnetic materials at radio frequencies. He pointed out that it was generally accepted that the losses in ferromagnetic materials subject to alternating fields are due to eddy currents, to hysteresis currents and to a third loss for which the term "residual loss" will be used here,‡ but that very little was known of the actual variation with frequency of these losses at radio frequencies. Some of the obscurities of this subject have been removed by more recent work on ferromagnetic laminae, and it is the object of this article to revise the above report in the light of this work.

Eddy Current Loss

In a manner similar to the production of a non-uniform distribution of current density by skin-effect in the case of a conductor carrying alternating currents, a non-uniform distribution of flux density is produced by eddy currents in the case of a metallic sheet subject to the influence of an alternating field. As a result, the apparent permeability of the material is reduced and the resistance losses in the material are increased. The increase in loss due to this phenomenon is called the eddy current loss.

Although the theory of eddy currents for homogeneous plane sheets was formulated by J. J. Thomson[2] many years ago, it did not receive complete experimental verification until very recently. The author[3] has demonstrated the validity of the simple eddy current theory in the case of non-magnetic materials, and it has been shown by Peterson and Wrathall[4] and independently by the author[5] that the attempts of many investigators to verify the theory in the case of magnetic materials failed because, in practice, such materials are rarely homogeneous. According to Peterson and Wrathall the inhomogeneity generally takes the form of a thin surface layer which they postulate has the same resistivity but a uniform permeability much lower than that of the interior. The author's investigations suggest, however, that the surface layer itself is not homogeneous, there being either a grading of permeability throughout its thickness or, more probably, a number of component layers of different permeability. Peterson and Wrathall have shown further that results in accordance with the simple eddy current theory are obtained when the complete layer is removed by etching.

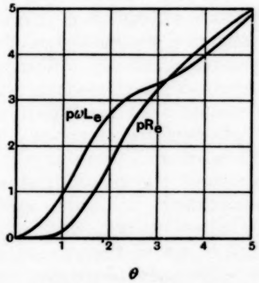

Fig. 1.—*Calculated R_e and ωL_e curves.*

The effect of a surface layer on the behaviour of ferromagnetic materials can be observed by measuring the impedance of a coil wound on a core of the material under consideration.

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* MS. accepted by the Editor October, 1937.

† These numbers refer to the list of references given at the end.

‡ Colebrook refers to this loss as "retardation" in translation of the German "Nachwirkung." It has also been variously termed "magnetic viscosity" or "square law hysteresis."

Scott [6] has shown that, in the case of a coil which encloses a metallic core built up of homogeneous annular laminations whose ratio of width to thickness is large, the resistance R_e and inductance L_e of the coil due to the presence of eddy currents alone are given respectively by equations (1) and (2), namely:

$$\frac{R_e}{2\pi f\mu k} = \frac{1}{\theta}\,\frac{\text{Sinh}\,\theta - \sin\theta}{\cosh\theta + \cos\theta} \quad \ldots \quad \ldots \quad (1)$$

$$\frac{L_e}{\mu k} = \frac{1}{\theta}\,\frac{\sinh\theta + \sin\theta}{\cosh\theta + \cos\theta} \quad \ldots \quad \ldots \quad (2)$$

where $\theta = 4\pi a\sqrt{\dfrac{\mu f}{10^9\,.\,\rho}}$;

$k = \dfrac{4\pi N^2 A}{l} \times 10^{-9}$;

$2a$ = thickness of lamination in cm;

ρ = resistivity of core, in ohms per cm. cube;

μ = permeability of core;

f = frequency, in cycles per sec.;

N = number of turns in coil winding;

A = area of cross-section, in cm²;

l = mean circumference of core, in cm;

These equations do not lend themselves to simplification except when θ is less than 1 or greater than 5. These conditions, however, cover the two regions which are usually of interest in the study of eddy current phenomena. When $\theta < 1$, the distribution of flux density throughout the cross-section of the lamination is not appreciably modified by the eddy currents, whereas, when $\theta > 5$, their action is such that the interior of the lamination is almost entirely screened from the flux. In the case of magnetic materials designed for normal operation at audio or carrier frequencies, the condition $\theta > 1$ is usually satisfied by frequencies in the normal operating range, and its performance at radio frequencies is obtained when $\theta > 5$. It is possible, however, to obtain thin laminations of low permeability and high resistivity which enable the condition $\theta < 1$ to be satisfied even at radio frequencies.

From equations (1) and (2)

$$\frac{R_e}{2\pi f L_e} = \frac{\sinh\theta - \sin\theta}{\sinh\theta + \sin\theta}$$

If this is plotted against θ^2 for values of $\theta < 1$, we obtain a straight line through the origin whose equation is

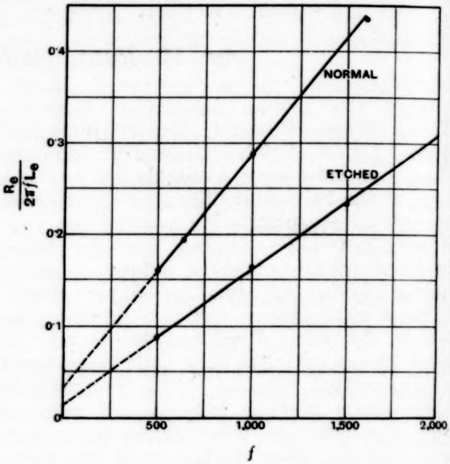

Fig. 2.—$\frac{R_e}{2\pi f L_e}$ — *f curves for* $\theta < 1$.

$$\frac{R_e}{2\pi f L_e} = 0.166\,\theta^2 = f\,.\,\tan\beta \quad \ldots \quad (3)$$

where $\tan\beta = \dfrac{26.2\,\mu a^2}{\rho\,.\,10^9}$ .. .. .. (4)

It can also be shown quite simply that when $\theta < 1$,

$$\frac{L_e}{\mu k} \simeq 1,$$

and $\dfrac{R_e}{f^2} = 0.205\,\pi^3 k^2 \mu^2 p$ .. .. (5)

where $p = \dfrac{8\pi a^2}{k\rho\,.\,10^9}$.

when $\theta > 5$, $\sinh\theta = \cosh\theta \gg 1$. Equations (1) and (2) therefore simplify to

$$\frac{R_e}{2\pi f\mu k} = \frac{L_e}{\mu k} = \frac{1}{\theta}$$

$$\text{or}\quad pR_e = p\,.\,2\pi f L_e = \theta \quad \ldots \quad \ldots \quad (6)$$

For intermediate values of θ, the corresponding values of R_e and L_e can be obtained from the curves shown in Fig. 1. The validity of the above equations when $\mu = 1$ has been demonstrated by measurements made on cores of non-magnetic materials.[3] When ferromagnetic cores of the type generally found in practice are employed, however, large discrepancies between the measured and calculated values appear. A typical example of the results obtained is illustrated by the curves marked "normal" in Figs. 2, 3 and 4. These are for a coil wound on a mumetal core and having the following particulars.

$$\mu = 6125 \; ; \; \rho = 42.1 \times 10^{-6} \; ; \; 2a = 0.0124 \; ;$$

$$A = 0.62 \; ; \; l = 34.5 \; ; \; N = 44.$$

Fig. 2 which gives the results for $\theta < 1$ shows that although the relationship between $\frac{R_e}{2\pi f L_e}$ and f is linear in accordance with equation (3), the line does not pass through the origin. Further, the slope of the line is 0.258×10^{-3} instead of 0.1465×10^{-3}, the value for $\tan \beta$ calculated from equation (4). Figs. 3 and 4 show that, when $\theta > 5$, equation (6) is not satisfied as the relationship between θ and $p. R_e$ and between θ and $p. 2\pi f L_e$ is not linear, also $\theta > p.R_e > p.2\pi f L_e$. When $\theta < 1$, the eddy current losses for a given current through the coil are therefore higher than those predicted by the simple eddy current theory, whereas they are lower when $\theta > 5$.

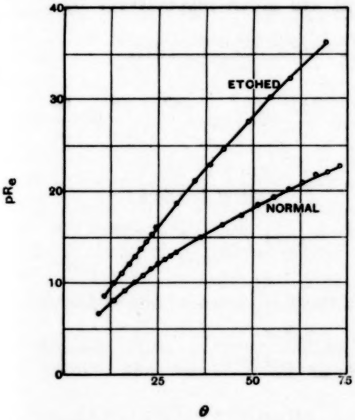

Fig. 3.—*Resistance measurements for* $\theta > 5$.

Ignoring the fact that the line of Fig. 2 does not pass through the origin, it is shown in the papers to which reference has been made that these results are, however, in accordance with the expected ones when the simple eddy current theory is modified to take into account the presence of a surface layer whose permeability is lower than the interior. Roughly, the effect of such a layer is as follows. When $\theta < 1$, although the eddy currents do not prevent the flux from penetrating the whole cross-section of the lamination, there will be a non-uniform distribution of flux density for a given magnetising force because owing to their difference in permeability the layer and the interior will have different flux densities. Since the eddy current loss is proportional to the square of the flux density (when $\theta < 1$), the loss for the composite lamination will be greater than the calculated value based on a uniform distribution of flux. Consequently, the actual resistance of the coil will be higher than the value obtained from equation (5). When $\theta > 5$ the demagnetising effect of the eddy currents is high enough for the interior of the laminations to be screened from the magnetic flux, with the result that the flux tends to be confined to the surface layer. The value for μ employed in equation (6) should therefore be the one corresponding to the surface layer and not to the lamination as a whole. This means that, at any given frequency, the values obtained for R_e and L_e will actually correspond to lower values of θ than those given in Figs. 3 and 4.

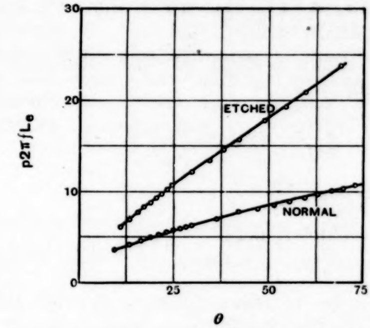

Fig. 4.—*Inductance measurements for* $\theta > 5$.

The author has shown [3] that it should be possible to calculate the total thickness of the surface layer from

$$a_2 = \frac{a}{2}\left(\frac{\tan\gamma}{\tan\beta} - 1\right) \quad \ldots \quad \ldots \quad (7)$$

where $\tan\gamma$ = slope of line obtained by plotting

$$\frac{R_e}{2\pi f L_e} \text{ against } f \text{ for } \theta < 1.$$

In our example,

$$a_2 = \frac{0.0062}{2}\left(\frac{0.258}{0.1465} - 1\right) = 2.36 \times 10^{-3} \text{ cm.}$$

In order to check equation (7), the thickness of the laminations was reduced by etching to 0.00985 cm. and the measurements for $\theta < 1$ were repeated. The results obtained are shown by the line marked "etched" in Fig. 2 which gives $\tan\gamma = 0.146 \times 10^{-3}$. The new value for $\tan\beta$ is 0.099×10^{-3}, so that by equation (7) the thickness of the surface layer remaining is 1.165×10^{-3} cm. The value which would be expected on the assumption that equation (7) is correct is

$$\{2.36 - 0.5\ (12.4 - 9.85)\}\ 10^{-3} = 1.085 \times 10^{-3} \text{ cm.}$$

which differs from the measured value by only 7.5 per cent. This difference is probably due to the inevitable variation of the thickness of the laminations themselves and also the variation between laminations. In any case, the two values are sufficiently close to justify the method employed to measure the thickness of the total surface layer.

The curves marked "etched" in Figs. 3 and 4 show the results obtained with the etched laminations for $\theta > 5$. It is seen that a removal of a portion of the surface layer definitely produces a change in the effect of the eddy currents, the values obtained for the resistance and inductance being brought nearer to those predicted by the simple theory.

Up to the present, the fact that the curves of Fig. 2 are not linear to the origin has been ignored. This phenomenon is thought to be due to a loss additional to the eddy current loss and it is discussed in greater detail later.

Hysteresis Loss

Since magnetic materials in communication apparatus are usually operated at low flux densities, it is customary to confine the analysis of hysteresis losses in such materials to the so-called Rayleigh region of permeability where

$$\mu_m = \mu_0 + \alpha H_m$$

α is constant, μ_0 is the initial permeability, and μ_m is the permeability corresponding to a maximum magnetising force H_m.

In the absence of eddy currents it has been shown by Jordan[7] and confirmed experimentally by Ellwood and Legg[8] that the resistance of a coil corresponding to the hysteresis loss is given by

$$R_h = \frac{8\alpha H_m}{3\mu_m} \cdot L_m f \quad \ldots \quad \ldots \quad (8)$$

where L_m = inductance of the coil for the given value of H_m

$$= k(\mu_0 + \alpha H_m) \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

When eddy currents are present they will modify the hysteresis and the hysteresis will modify the eddy currents. The mutual effect of eddy currents and hysteresis for sheets has been analysed by Cauer[9] who has shown that the resulting resistance and inductance of a coil when both losses are present are given respectively by

$$R_{eh} = \frac{2\pi f \mu_0 k}{\theta}\,\frac{\sinh\theta - \sin\theta}{\cosh\theta + \cos\theta} + \frac{8\alpha H_m f k}{3}\left(1 + \frac{\pi\theta^2}{4} - \frac{7\theta^4}{60} - \frac{\theta^6}{40} + -\right) \quad (10)$$

$$L_{eh} = \frac{\mu_0 k}{\theta} \cdot \frac{\sinh\theta + \sin\theta}{\cosh\theta + \cos\theta} + k\alpha H_m\left(1 - \frac{4\theta^2}{9\pi} - \frac{7\theta^4}{60} + \frac{2\theta^6}{45\pi} + -\right) \quad (11)$$

From these equations Legg[10] derives

$$\frac{R_e k}{L_{eh}} = \frac{16\pi^3 a^2}{3\rho \cdot 10^9}\mu_m f^2\left\{1 - \frac{4}{140}\,(1 + 5\lambda B_m) + \ldots\right\} + \frac{8}{3}\lambda H_m \mu_0 f\left\{1 - \frac{4}{36}(1 - 5\lambda B_m) + -\right\} \quad (12)$$

where $B_m = \mu_m H_m$;

$$\lambda = \frac{\mu_m - \mu_0}{\mu_0 B_m};$$

and series terms in λB_m higher than the first power are neglected.

Comparison of equations (10) and (11) with equations (1), (2), (8) and (9) shows that, when θ is small, it is possible to ignore the interaction of eddy currents and hysteresis and to treat them as independent of each other; that is, it can be assumed that the eddy currents do not disturb the distribution of flux density. In practice, this condition will apply with very small error so long as $\theta < 1$. Equation (12) then reduces to

$$\frac{R_{eh}}{\mu_m f L_{eh}} = hB_m + ef \quad \ldots \quad \ldots \quad (13)$$

where $h = \frac{8}{3}\lambda\frac{\mu_0}{\mu_m{}^2}$;

and $e = \frac{16\pi^3 a^2}{3\rho . 10^9}$.

When $\theta > 5$, the author has shown [5] that Cauer's analysis can be considerably simplified to give

$$R_{eh} = \frac{2\pi f\mu_0 k}{\theta}\left(1 + 0.504\frac{\alpha H_m}{\mu_0}\right) \quad \ldots \quad (14)$$

$$L_{eh} = \frac{\mu_0 k}{\theta}\left(1 + 0.331\frac{\alpha H_m}{\mu_0}\right) \quad \ldots \quad (15)$$

These equations show that, when the interaction between eddy currents and hysteresis is large, both the resistance and the inductance increase linearly with the magnetising current. This also applies to the apparent permeability which is given by $L_{eh}//k$. Further, for a given value of H_m, the apparent permeability varies as $\frac{1}{\theta}$, i.e., it declines with increase of frequency. The measurements on the variation of permeability with frequency made by Wien [11] confirm the linearity between L_{eh} and H_m and the reduction in effective permeability with frequency, although he does not give sufficient data to enable a quantitive check to be made.

By rejecting terms in αH_m higher than the first power, we obtain from equations (14) and (15)

$$\frac{R_{eh}}{2\pi f L_{eh}} = 1 + cH_m \quad \ldots \quad \ldots \quad (16)$$

where $c = \frac{0.173\alpha}{\mu_0}$.

In the foregoing discussion on hysteresis it has been assumed that the core is homogeneous. Since it is possible to ignore the interaction of eddy currents and hysteresis when $\theta < 1$, and the hysteresis loss is proportional to the first power of the flux density in the Rayleigh region, equation (13) will hold even when there is a surface layer, although, according to equation (17) of reference (3), e will now be given by

$$e_1 = \frac{16\pi^3 a^2}{3\rho . 10^9}\left(1 + \frac{2a_2}{a}\right).$$

Equation (16) will, however, no longer apply because $\frac{R_{eh}}{2\pi f L_{eh}}$ changes with the frequency when there is a surface layer.

Residual Loss

In connection with Fig. 2, it was mentioned that the cause of the lines not passing through the origin is thought to be a loss termed the residual loss which is additional to the eddy current loss. In a recent paper [8] Ellwood and Legg show that the residual loss per cycle is independent of the magnetising force, that it is zero at zero frequency and increases with frequency for a small portion of the $\frac{R_e}{2\pi f L_e} - f$ curve. Beyond this point the loss per cycle remains constant at higher frequencies. The authors give the results of measurements made on a coil for which $\theta = 1$ when $f = 4840$. They show that the residual loss per cycle increases until $f = 500$ and then remains constant until 10,000 cycles per second, the highest test frequency employed. Their measurements show also that, except for low values of θ, the residual loss is only a small fraction of the eddy current loss. For example, at 5,000 cycles per second it is less than 3 per cent. of the eddy current loss. When θ is greater than 1, it follows from the agreement between the measured values and those calculated from the simple eddy current theory obtained by Peterson and Wrathall for etched laminations that the residual loss can comprise only a negligible portion of the eddy current loss.

As far as the author knows, no mathematical treatment of residual loss has been published, although a number of theories have been advanced to explain the phenomenon. A critical review of a number of these theories is given by Ellwood in an earlier paper [12] and in their recent paper [8] he and Legg suggest that the residual loss may be due to elastic hysteresis or even simple mechanical friction, with magnetostriction providing the necessary coupling between the elastic or frictional variables and the magnetising field. They conclude that the magnitude of the loss and its variation with frequency should depend on the magnetostrictive constant for the material and on the types of dissipative constraints.

In practice, an accurate calculation of the total losses to be expected for a ferromagnetic material of known dimensions, permeability and resistivity is complicated by the presence of the surface layer and by the existence of the residual loss. Equation (13) provides, however, a simple practical means of separating the various losses when $\theta < 1$ even when there is a surface layer. The procedure, full details of which are given by Legg [10] and by Ellwood and Legg [8], is to plot first the measured values of $\frac{R_{eh}}{fL_{eh}}$ against B_m with f as the parameter and then the values of $\frac{R_{eh}}{fL_{eh}}$ against f for $B_m = 0$. As explained above, the surface layer makes the problem much more complicated when $\theta > 5$, even though the residual loss can be ignored. The eddy current loss in the absence of hysteresis can, however, be determined for any given frequency by measuring the variation of resistance and inductance of the coil with the magnetising force and then obtaining their values for $B_m = 0$ by interpolation.

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Correspondence

Magnetron and Generation of U-s. Waves

To the Editor, The Wireless Engineer.

SIR,—I follow the articles in your magazine with the greatest interest. I wish to refer to the editorial article in the January number in which you describe my work on the above subject. You suggest that on the grounds of symmetry a second cathode might be employed at the other end of the cylindrical anode. As mentioned in my article, it is necessary to fit baffle plates at the open ends of the cylinder, in order to prevent electrons passing out to the glass walls. This is especially necessary at the end remote from the cathode. If the magnetic field is too strong—which can easily happen during adjustments—the baffle plate at this end becomes overheated, due to the electrons following a spiral path of such small diameter that they never reach the segments of the anode cylinder but pass through and strike the end plate. If now there were also a cathode at this end, the two cathodes would mutually bombard and heat one another and thus destroy the very advantage which is gained by having the cathode at *one* end. With proper design and adjustment the electronic bombardment of the end plate is small, but enough to lead to cathode heating if a second cathode were present.

Electr.-Ges. Sanitas m.b.H., ADOLF HELBIG.
Berlin.

Background Noise

To the Editor, The Wireless Engineer.

SIR,—Before replying in detail to Mr. Bell's letter published in the April, 1938 issue of *The Wireless Engineer* and relating to the first part of our paper on "Background Noise Produced by Valves and Circuits," we would remark that it was our intention to limit the theory to that which is either generally accepted or which appears to be borne out by our measurements. In this way we hoped to avoid raising controversial questions relating to the causes of valve noise, but it now seems that we have exceeded these self-imposed terms of reference.

Space Charge Limited Diodes.

Mr. Bell wishes us to justify our statement "If the sole effect of space-charge were the formation of a potential barrier, the effective temperature of the diode resistance would be the same as in the absence of space-charge." He then adds "My own conclusions were that in the absence of space-charge the temperature is indeterminate."

It will be noted that we use the term *effective* temperature, i.e., the temperature that a solid conductor of the same resistance must have to produce the same noise. Now this effective temperature is a measurable quantity and cannot therefore be indeterminate. For a temperature limited diode it is infinite and for a diode in the retardation condition it is half the cathode temperature.

If the sole effect of a space charge were the formation of a potential barrier, which did not fluctuate either in potential or in position, then the impedance of the valve would be infinite since the anode potential could not affect the number of electrons passing the potential barrier. However, the noise current will be finite, so that it follows from the equation :—

$$(\Delta I)^2 = \frac{4kT_e}{R}\Delta f \quad \cdots \quad \cdots \quad \cdots \quad (1)$$

that T_e must be infinite.

In the absence of space charge and with the anode at a positive potential the diode would be saturated and hence T_e will also be infinite.

It appears that Mr. Bell, being mainly concerned with theory, has considered the temperature of an electron stream in terms of the random velocities of the electrons. On the other hand, we have been chiefly interested in the experimental side and have therefore used an effective temperature dependent on the behaviour of a valve when connected in a circuit.

It is to be hoped that further theoretical progress will show the connection between the two. Because of this we have defined the effective temperature of a triode in such a way as to eliminate the magnifying factor μ (see below), and have refrained from employing the term temperature in connection with a screen grid valve where it is manifestly inappropriate owing to the random current sharing with the screen.

Triodes.

The mechanism whereby an amplifying valve apparently magnifies the effective temperature of the electron stream is as follows. Let the current flowing through the grid bear a fluctuation current ΔI such that if it were to strike a solid electrode in the grid plane the effective temperature of the diode so formed would be T_e. The impedance of the diode would be approximately $1/g$. Now in travelling to the anode (assuming the anode earthed to A.C.), the fluctuation current ΔI will be unchanged. However, the impedance of the valve will now be $R_a = \frac{\mu}{g}$. Reference to equation (1) shows that the effective temperature will now be μT_e. In other words, the temperature of the valve appears to be multiplied μ times. By connecting the grid capacitively to the anode the temperature T_e can be measured, and, as has been pointed out, this fluctuates less from valve to valve than μT.

Screen Grid Valves.

Mr. Bell asks " If the current reaching the anode is in any case random . . . can sharing it with the screen in a four electrode valve make it more random."

A completely random fluctuation is one for which ΔI is given by the equation

$$(\Delta I)^2 = 2eI\,\Delta f \qquad \ldots \quad \ldots \quad \ldots \quad (2)$$

The fluctuation current in a triode valve is by no means completely random, but can be made more random by sharing with a screen.

It is true that our equation (16) page 132 (*loc. cit*)

$$R'_n = \frac{20\,I_S}{g^2} \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

only applies accurately when I_S is small compared with the anode current. A more accurate formula based on the theory of probability has since been obtained. It is :—

$$R'_n = \frac{20\,I_S\,I_A}{g^2(I_S + I_A)} \qquad \ldots \quad \ldots \quad \ldots \quad (4$$

When $I_S << I_A$ this becomes identical with the approximate equation (3). The complete formula for the noise resistance of a screen grid valve in the absence of secondary emission can be written :—

$$R_n = \left[\frac{\alpha}{g} + \frac{20\,I_S}{g^2}\right]\frac{I_A}{I_A + I_S} \qquad \ldots \quad \ldots \quad (5)$$

where α is a constant which cannot be less than unity, and for most valves so far tested (except Acorns) under working conditions is of the order of 2. This equation has been found very useful in giving a rough value for the noise resistance of a large number of commercial valves.

W. S. Percival, W. L. Horwood,
Electric and Musical Industries, Ltd.

The Optimum Value of the Angle ϕ

To the Editor, The Wireless Engineer.

Sir,—I have read with interest Mr. Kósas discussion of " The Optimum Value of the Angle ϕ " in his paper on " High-Frequency Power Amplifiers " (*The Wireless Engineer*, December, 1937, p. 650), but I should like to point out that the approximate formulas used in this paper may sometimes lead to rather considerable errors.

For instance, the approximate formulas give $\phi_{\text{mod opt}} = 84$ deg. and $\phi_{\text{opt}} = 78.5$ deg. (if $\cos\phi = 2\cos\phi_{\text{mod}}$, corresponding to $m = 100\,\%$), whereas a derivation of the formula

$$y = \frac{\phi - \sin\phi\cos\phi}{\sin\phi - \phi\cos\phi} \cdot \frac{\phi_{\text{mod}} - \sin\phi_{\text{mod}} \,.\, \cos\phi_{\text{mod}}}{1 - \cos\phi_{\text{mod}}}$$
$$\simeq \frac{(\phi_{\text{mod}} - \sin\phi_{\text{mod}} \,.\, \cos\phi_{\text{mod}})^2}{(1 - \cos\phi_{\text{mod}})\,(\sin\phi_{\text{mod}} - \phi_{\text{mod}} \,.\, \cos\phi_{\text{mod}})}$$

will give only one single root between 0 and 180 deg. (if $\phi_{\text{mod}} = 0$ is ignored), namely $\phi_{\text{mod opt}} = 88$ deg. 17′ e.g. $\phi_{\text{opt}} = 86$ deg. 34′. The only approximation made here is that ϕ has been replaced by ϕ_{mod} in the above formula for y, but if also this approximation is omitted (e.g. if $\phi_{\text{mod}} = f(\phi)$ from the equation $\cos\phi = 2\cos\phi_{\text{mod}}$, is inserted in the first formula for y, so that y is obtained as an exact function of ϕ only), ϕ_{opt} will be something between 88 deg. 17′ and 86 deg. 34′, say $\phi_{\text{opt}} = 87.5$ deg. In this case the total error caused by the approximations thus amounts to about $87.5 - 78.5 = 9$ deg. However, the value of ϕ is not at all critical as will be seen from the following table in which η, W_2 and ηW_2 have been put equal to unity at $\phi = 90$ deg.

ϕ	η	W_2	ηW_2
78.5	1.059	0.9343	0.9890
84	1.031	0.9683	0.9979
87	1.015	0.9848	1.0000
88.5	1.008	0.9927	1.0004
90	1.000	1.000	1.0000
100	0.9473	1.0395	0.9839
120	0.8410	1.0726	0.9019
122	0.8309	1.0730	0.8917
125	0.8156	1.0728	0.8748

It **is** seen from this table that a variation of ϕ between 87 and 90 deg. will change ηW_2 by less than 0.04 per cent. If only the maximum of ηW_2 is considered, it is therefore of no importance if ϕ_{opt} is chosen = 87 deg., 88.5 deg. or 90 deg.

With regard to $W_{2\,\text{max}}$, a derivation of the exact formula will give $\phi_{\text{mod opt}} = 122.5$ deg., whereas the approximate formulas (3a) and (11) will give $\phi_{\text{mod opt}} = 107$ deg.

Victor Olsson,
Stockholms Rundradiostation, Spånga, Sweden.

Abstracts and References

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For the information of new readers it is pointed out that the length of an abstract is generally no indication of the importance of the work concerned. An important paper in English, in a journal likely to be readily accessible, may be dealt with by a square-bracketed addition to the title, while a paper of similar importance in German or Russian may be given a long abstract. In addition to these factors of difficulty of language and accessibility, the nature of the work has, of course, a great influence on the useful length of its abstract.

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PROPAGATION OF WAVES

1735. SPACE PROPAGATION IN THE BOUNDARY REGION BETWEEN SHORT WAVES AND QUASI-OPTICAL WAVES.—E. Fendler. (*Hochf:tech. u. Elek:akus.*, Jan. 1938, Vol. 51, No. 1, pp. 30–33.)

The shortest wavelength which can be reflected from the ionosphere may vary between 16 and 4 m; the times and other connections of these variations are discussed in § 1, with the help of diagrams. Fig. 1 gives a general view over the possibilities of communication on a 10 m wavelength, Fig. 2 the times of traffic on 10 m between Germany and North America. Fig. 3 shows the days on which no traffic was possible; their connection with magnetic storms and solar disturbances is discussed. Fig. 4 gives wavelength ranges of emitters audible on their true wavelength or on harmonics, Fig. 5 days of good audibility between 7 and 5 m. § II deals with propagation of emitter harmonics; Fig. 7 compares the received strength of North American 10 m stations with that of the first harmonic of a 20 m station, Fig. 8 their probable approximate ionospheric paths. It is found that the signals on the original wavelength and on the harmonic are mutually exclusive. The possibility of deducing ionospheric variations from such results is indicated.

1736. INVESTIGATIONS ON THE PROPAGATION OF ELECTROMAGNETIC WAVES BELOW 11 METRES OVER LONG DISTANCES [A.—Transoceanic: B.—European: based on Ulm (Germany) Observations on Many Transmissions of Various Kinds, particularly the Harmonics of Commercial Short-Wave Stations].—H. A. G. Hess. (*Funktech. Monatshefte*, Feb. 1938, No. 2, pp. 38–50.)

Author's summary:—" The important fact was established, by systematic investigations, that no connection exists between the propagation of waves between 7 and 11 metres over transoceanic distances [several thousand kilometres] and the propagation —only to be observed during the summer half of the year—of such waves over European distances [several hundred kilometres]. These two types of propagation must be based on different causes.

" *A.—Propagation over transoceanic distances.* The writer's observations and investigations during 1935 and 1936 led to the knowledge that a propagation of waves around 10 m in the North/South direction between Europe and S. Africa exists all the year round at definite hours of the daytime and can be considered as regular. Propagation in the East/West direction (*e.g.* Europe to N. America or Europe to E. Asia) by waves around 10 m in the Northern hemisphere occurs only during the winter half of the year at day times of strongest ionisation by the sun along the great-circle path, and occurs regularly except for a few occasional disturbances. Ionospheric disturbances, probably caused by cosmic effects and always accompanied by a disturbance of the earth's magnetic field, may suppress completely all propagation of waves around 10 m in the East/West direction while leaving propagation in the North/South direction undisturbed [*cf.* same writer, 3589 of 1937]. The fade-outs in the East/West direction caused by ionospheric disturbances are considerably more numerous and severe for waves around 10 m than for waves around 14 m. Systematic investigations on waves around 10 m between Europe and N. America during October 1936 gave a regularity figure of 90% during the daylight hours in question. Propagation of waves around 10 m along paths passing near to the North pole (*e.g.* Europe to California) and over very great distances (*e.g.* Europe to Australia) cannot on the other hand be regarded as regular, since it is subject to very severe fluctuations.

" Waves around 8 m require, for their reflection at the Kennelly-Heaviside layer, a still higher degree of ionisation than the waves around 10 m. The 8 m waves therefore are, to an extreme extent, ' daylight waves.' In the North/South direction their propagation should be possible throughout the whole year at definite times of day, while in the East/West direction such propagation will occur, very frequently indeed but not what can be called regularly, only during the winter half of the year in the Northern hemisphere over daylight paths. Ionisation disturbances in the Kennelly-Heaviside layer, accompanied by magnetic-field disturbances, cause fade-outs in the East/West propagation of waves around 8 m to a greater extent than is the case with waves around 10 m.

"*B.—Propagation over European distances.* The ultra-short-wave propagation observed over shorter distances of some hundreds of kilometres, occurring in the months of strongest ionisation by the sun, in summer, in a very irregular manner and associated with strong ionisation of the lower layers of the ionosphere, could not be shown to have any connection with the regularities of the transoceanic propagation. An attempt was therefore made to explain these irregularities in terms of meteorological processes. A comparison [pp. 48–50] of the u.s.w. propagation curves with the weather charts of the State Meteorological Service shows that such correlation is, in fact, possible."

1737. Audibility of a Limiting Wave (10 m) and Solar Phenomena [in 1936/37].—K. Stoye. (*E.N.T.*, Jan. 1938, Vol. 15, No. 1, pp. 26–27.)

For previous work *see* 446 of 1937. Here, data of reception on a 10 m wavelength from distant stations during 1936/37 are given; the audibility changed in correspondence with the increase of solar activity. The best transmission conditions were found in the first half of March and in October and November. Fig. 5 illustrates the connection between the magnetic character of the days in 1936 and the audibility of 10 m waves; it confirms the periodicity of the audibility and its dependence on solar emission regions.

1738. Propagation of 30-Megacycle Radio Waves [Japanese Observations 1936–Feb. 1937, Long and Short Distance: Two Modes of Propagation—by Scattered Reflection and by Regular Reflection, both depending on Max. Electron Density of F_2 Region and Its Apparent Height: etc.].—K. Maeda & T. Tukada. (*Electrot. Journ.*, Tokyo, March 1938, Vol. 2, No. 3, pp. 65–69.)

Propagation over short distances follows the scattered-reflection mode, but with increasing distance it gradually begins to follow the mode depending on regular reflection, and at long distances depends mainly on this. Good response in short-distance propagation occurs when the F_2 critical frequency is large if the F_2 height is low; if the height is high, a comparatively small critical frequency is sufficient. In long-distance propagation these relations are reversed. The propagation contour curves for communication distances within 4000 km are drawn. Seasonal variations, and annual variation and its relation to sunspot numbers, are discussed briefly.

1739. Discussion on "Ultra-Short-Wave Propagation along the Curved Earth's Surface" [particularly the Burrows-Decino-Hunt Formula and the Writers' Modification of It to apply to Aerials at Aeroplane Heights].—von Handel & Pfister: Burrows. (*Proc. Inst. Rad. Eng.*, Feb. 1938, Vol. 26, No. 2, pp. 240-245.) *See* 2441 of 1937 and back reference.

1740. The Impedance Concept and Its Application to Problems of Reflection, Refraction, Shielding, and Power Absorption.—S. A. Schelkunoff. (*Bell S Tech. Journ.*, Jan. 1938, Vol. 17, No. 1, pp. 17–48.)

"Part I discusses broadly the ratios to which the term 'impedance' can appropriately be applied in a wide variety of physical fields, ranging from electric circuits and heat conduction to electromagnetic radiation. In this part the concept is gradually broadened until . . . it has acquired the property of *direction* [although impedances are not vectors]. Parts II and III consider the general laws governing reflection, refraction, shielding, and power absorption, and re-phrase them as theorems regarding the generalised impedances. . ."

1741. The Propagation of Electromagnetic Waves in Water.—G.W.O.H: Brüne. (*Wireless Engineer*, Feb. 1938, Vol. 15, No. 173, pp. 67–68.) Editorial on the paper dealt with in 38 of January.

1742. The Mutual Modulation Effect of Electromagnetic Waves in the Ionosphere.—Grosskopf. (*See* 1849.)

1743. A Wireless Interferometer [Use of Pair of Spaced Frame Aerials for Determination of Spread in Direction of Scattered Rays: Reflection of Sporadic Echoes from Irregular High-Density Patches in E Region].—T. L. Eckersley. (*Nature*, 26th Feb. 1938, Vol. 141, p. 369–370.) For a previous letter *see* 397 of February.

1744. Temperatures in the Stratosphere [and a Denunciation of Appleton's "Furnace Belt" Theory of Ionosphere].—C. G. Philp. (*World-Radio*, 11th March 1938, Vol. 26, pp. 14–15.) Concluded from the issue of 4th March.

1745. The Reflection Coefficients of Ionospheric Regions.—E. V. Appleton & J. H. Piddington. (*Proc. Roy. Soc.*, Series A, 18th Feb. 1938, Vol. 164, No. 919, pp. 467–476.) The full paper, an abstract of which was referred to in 806 of March.

1746. Magnetic Double Refraction of Medium Radio Waves in the Ionosphere [Separation of Components of Split F Echo increases with Frequency: explained by Difference in Polarisation of Components: Doubts on Explanation of Martyn & Munro of Two Normal Components of which One penetrates Over-Dense Stratum].—E. V. Appleton, F. T. Farmer, & J. A. Ratcliffe. (*Nature*, 5th March 1938, Vol. 141, pp. 409–410.)

1747. Studies of Region E of the Ionosphere [by Method allowing Rapid Variations to be followed: True Critical Frequencies observed during Winter, "Threshold Frequencies" during Summer: No Correlation between Thunderstorms and E-Region Behaviour: No Correlation between Nocturnal E-Region Ionisation and Barometric Pressure].—J. E. Best, F. T. Farmer, & J. A. Ratcliffe. (*Proc. Roy. Soc.*, Series A, 7th Jan. 1938, Vol. 164, No. 916, pp. 96–116.)

1748. The Diurnal Variation of the Ionospheric Absorption of Wireless Waves.—J. E. Best & J. A. Ratcliffe. (*Proc. Phys. Soc.*, March 1938, Vol. 50, Part 2, pp. 233–246.)

The structure of the E region was studied by observing the variation, with the sun's zenith angle, of E-region absorption of echoes from the F region. Experiments were made in the afternoons of days of "quiet" ionospheric behaviour, as judged by criteria described. The results can be explained on the assumption that absorption takes place in the lower portion of a simple E region of Chapman's type.

1749. High Latitude Radio Observations.—A. B. Whatman & R. A. Hamilton. (*Proc. Phys. Soc.*, March 1938, Vol. 50, Part 2, pp. 217–232.)

Authors' summary:—"Observations were made on the ionosphere for nearly a year at 80° 23′ N, 19° 31′ E. It was found that at local noon the E region was present throughout the winter except on a few days which were magnetically disturbed. The electron density in this region is at a minimum in midwinter and a maximum at midsummer. The F$_1$ region is observed at noon only during the summer months, with maximum electron density at midsummer. The annual variation of maximum ionisation in the F$_2$ region is irregular and not very great, but the electron density is at a maximum in spring and in late autumn. The diurnal variation of electron density in the F$_2$ region is more marked in the dark period, with a day to night ratio of 2.3 : 1, than in the summer solstice period when the ratio is 1.5 : 1. This latter figure, which is also the ratio for the E and F$_1$ region, is in fair agreement with the ratio of 1.63 : 1 deduced theoretically on the assumption that the ionising power is proportional to the altitude of the sun. In all cases the minimum is near midnight, with maxima before and after noon and a sub-minimum near noon.

"The effect of magnetic storms is to increase the electron density in the absorbing region below the E region and, in the summer, to reduce markedly the electron density in the F$_2$ region. Reflections from the persistent E region persist to very high frequencies, especially between 1200 and 1800 G.M.T. An intense E region, with a high reflection coefficient, occurs at all seasons during magnetically quiet conditions, and occurs almost solely between 1400 and 2300 G.M.T. No special conditions in the ionosphere obtain when the aurora is overhead and absorption is not usually markedly increased under such condition." For eclipse results *see* 848 of 1937.

1750. Photoelectric Ionisation in the Ionosphere.—E. O. Hulburt. (*Phys. Review*, 1st March 1938, Vol. 53, No. 5, pp. 344–351.)

"The photoelectric theory is worked out in detail and is compared with experiment with greater rigour than has been possible hitherto. The conclusion is reached that F$_2$ arises from the ionisation of oxygen and nitrogen and that F$_1$ may be due to the modification of F$_2$ by winds and expansion of the atmosphere. No quantitative explanation of the origin of the E region emerges from the equations."

1751. Atmospheric Absorption [of Light] and Molecular Diffusion, from the Measurements of the Smithsonian Institute at Montezuma.—T. Kiu. (*Comptes Rendus*, 7th Feb. 1938, Vol. 206, No. 6, pp. 452–455.)

1752. Meteoric Ionisation in the E Region of the Ionosphere [Correlation of Number of Meteors entering Earth's Atmosphere and Frequency of Reflection of Radio Waves from Ionic Clouds suggests that these Ionic Clouds are due to Passage of Meteors].—A. M. Skellett. (*Nature*, 12th March 1938, Vol. 141, p. 472.)

1753. On Three Different Types of Fading and the Influence of Meteors on the Ionospheric Layers [Dellinger Effect, Aurora Effect, and E-Region (Meteor) Effect].—G. Leithäuser. (*Funktech. Monatshefte*, Feb. 1938, No. 2, pp. 33–50.) Following on the papers dealt with in 400 of February & 1298 of April. *Cf.* also Morgenroth, 823 of March.

1754. Measures to reduce Effects of Fading in Picture Transmission between Berlin and Tokyo, *and* Fading- and Echo-Phenomena in the Propagation of Radio Pictures, and Their Elimination ["Pulse Transmission" System].—Amisima & Kobayashi: Hudec. (*See* 1976 & 1977.)

1755. On the Periodicity of the Dellinger Effect.—I. Ozeki. (*Nippon Elec. Comm. Eng.*, Dec. 1937, No. 8, pp. 517–521.) A summary was dealt with in 2852 of 1937.

1756. Discussion on "The Fading Characteristics of the Top-Loaded WCAU Antenna" [and the Necessity that Both Intensity and Phase of Sky Wave should Vary].—Brown & Leitch. (*Proc. Inst. Rad. Eng.*, Jan. 1938, Vol. 26, No. 1, pp. 115–121.) *See* 2964 of 1937.

1757. Ionisation, Negative Ion Formation, and Recombination in the Ionosphere.—N. E. Bradbury. (*Phys. Review*, 15th Jan. 1938, Series 2, Vol. 53, No. 2, p. 210: abstract only.)

"It is suggested that the E and F$_1$ regions are formed as the result of the absorption of special bands of solar radiation and that negative ion formation is the predominant process in these regions. A sufficient number of electrons exists, however, to cause the reflection of electromagnetic waves. The F$_2$ region is probably not due to the absorption of any special band of solar radiation but owes its formation to the preponderance at this elevation of electron/positive-ion recombination over negative ion formation during the day. The characteristics of the E and F$_1$ regions are discussed quantitatively and compared with experimental observations. A qualitative discussion is given for the F$_2$ region."

1758. The Recombination of Ions in Pure Oxygen as a Function of Pressure and Temperature [Experimental Agreement with Thomson and Loeb Theories].—M. E. Gardner. (*Phys. Review*, 1st Jan. 1938, Series 2, Vol. 53, No. 1, pp. 75-83.) For theory *see* 3597 of 1937.

1759. Characteristics of the Ionosphere at Washington, D.C., November, 1937: December, 1937.—Gilliland & others. (*Proc. Inst. Rad. Eng.*, Jan. 1938, Vol. 26, No. 1, pp. 112–114: Feb. 1938, No. 2, pp. 236–239.) Including a type of high day-time absorption (apparently in lower part of, or below, the E layer) occurring frequently during latter half of December for last year or two, producing fade-outs without sudden onset and lasting for several hours.

1760. The Excitation of Gases by Electron Collision at Very Low Gas Pressures [Experimental Arrangement for Production of Intensive Spectra at Low Pressures by Magnetically-Concentrated Electron Beam: General Properties of Discharge: Pressure Variation of Argon Discharge: Space-Charge Effect at Very Low Pressures].—W. von Meyeren. (*Ann. der Physik*, Series 5, No. 2, Vol. 31, 1938, pp. 164-176.)

1761. The Effect of Cathode Material on the Second Townsend Coefficient for Ionisation by Collision in Pure and Contaminated N_2 Gas.—W. E. Bowls. (*Phys. Review*, 15th Jan. 1938, Series 2, Vol. 53, No. 2, p. 210: abstract only.)

1762. The Influence of Radiation on Ionisation Equilibrium [Quantum Theory giving Generalised Ionisation Formula for Thermodynamical Equilibrium of Assembly of Atoms, Ions, Electrons, Radiation].—B. Srivastara. (*Proc. Roy. Soc.*, Series A, 4th Feb. 1938, Vol. 164, No. 918, p. S 17: abstract only.)

1763. Diffusion of Electrons in a Magnetic Field.—J. S. Townsend: Tonks. (*Phil. Mag.*, March 1938, Series 7, Vol. 25, No. 168, pp. 459–470.) Further exposition and answers to criticism by Tonks (2864 of 1937: *see* also 26 of January) of Townsend's theory.

1764. Some Aspects of Active Nitrogen [Large Effect on Discharge-Tube Spectra of Traces of Impurity: Electrical Mechanism for Production of Negative Nitrogen Bands in Auroral Nitrogen Afterglow].—D. B. McNeill. (*Phil. Mag.*, March 1938, Series 7, Vol. 25, No. 168, pp. 471–475.)

1765. The Aurora Borealis of 25th Jan. 1938 observed at the Pic du Midi [Description: Spectral Lines and Their Intensities: Green and Red Rays, No Exceptional Yellow].—H. Garrigue & H. Camichel. (*Comptes Rendus*, 14th Feb. 1938, Vol. 206, No. 7, pp. 527–529.)

1766. Spectrum of the Aurora of 25th January 1938.—J. Dufay & J. Gauzit. (*Comptes Rendus*, 21st Feb. 1938, Vol. 206, No. 8, p. 619.) For other reports *see* 1301/1303 of April, and 1765, above.

1767. Observation of a New Fluorescence Phenomenon in the Upper Atmosphere: Presence, and Intensity Variations, of the Radiation λ 5893 Å in the Twilight Sky.—R. Bernard. (*Comptes Rendus*, 7th Feb. 1938, Vol. 206, No. 6, pp. 448–450.)

1768. Observations made in the Highest Stratosphere Flight [including Ozone and Conductivity Measurements, Air Composition, etc: Description of Results of Flight of Explorer II on 11th Nov. 1935].—(*Nature*, 12th Feb. 1938, Vol. 141, pp. 270–274.)

1769. The Reflection Coefficient of the Earth's Surface for Radio Waves [Curves for Its Determination (by, at Most, Two Interpolations) for Any Angle of Incidence, Any State of Polarisation, and Any Electrical Constants of Ground: or for Converse Process].—J. S. McPetrie. (*Journ. I.E.E.*, Feb. 1938, Vol. 82, No. 494, pp. 214–218.)

1770. The Shadow of a Straight Edge [Mathematical Solution, based upon Properties of Geometrical Shadow, for Point Wave Source and Incident Plane Wave: Diffraction in Presence of Total Reflection at Surface of Separation of Two Media of Different Refractive Indices].—E. T. Hanson. (*Phil. Trans. Roy. Soc.*, Series A, 7th Feb. 1938, Vol. 237, No. 772, pp. 35–65.)

1771. "Nouvelle Theorie sur le Mécanisme des Radiations lumineuses" [Magneto-Photon Theory: Book Review].—C. L. Mayer. (*Electrician*, 25th Feb. 1938, Vol. 120, p. 236.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

1772. Directional Recording of Radio Atmospherics [Description of Apparatus (Polar Diagram has Width of 20° without Ambiguity) and Analysis of 3 Years' Records: Curves for Rough Determination of Probable Intensity in Any Direction at Any Time].—F. E. Lutkin. (*Journ. I.E.E.*, March 1938, Vol. 82, No. 495, pp. 289–302.) From the National Physical Laboratory.

1773. Snow Static Effects on Radio Reception.—H. M. Hucke. (*Proc. Inst. Rad. Eng.*, Jan. 1938, Vol. 26, No. 1, p. 12: summary only.) *See* also 3603 of 1937.

1774. Applications of the Modulating Electrode of Television Cathode-Ray Tubes in Investigations of the Wave-Form of Atmospherics [Apparatus preventing Flow of Electron-Beam Current except in Presence of Deflecting Voltage in Excess of Defined Minimum, and/or for Predetermined Time following Occurrence of Specified Deflecting Voltage].—H. C. Webster. (*Proc. Phys. Soc.*, 1st Nov. 1937, Vol. 49, Part 6, No. 276, pp. 658–662.)

1775. An Aperiodic Amplifier for Investigating the Wave-Form of Atmospherics [by C-R Oscillograph: independent of Frequency between 50 & 5×10^5 c/s: Push-Pull Device for eliminating Mains Fluctuations].—H. C. Webster. (*Proc. Phys. Soc.*, 1st Nov. 1937, Vol. 49, Part 6, No. 276, pp. 654–657.) *See* also 1774, above.

1776. Indirect Lightning Surges on Power Lines [Oscillographic Investigations in Sweden during Last Three Years].—H. Norinder. (*E.T.Z.*, 3rd Feb. 1938, Vol. 59, No. 5, pp. 105-111.)

1777. Discussion on "Distortion of Travelling Waves by Corona."—Skilling & Dykes. (*Elec. Engineering*, Feb. 1938, Vol. 57, No. 2, Supp. pp. 102-104.) *See* 3608 of 1937.

1778. The Measurement of the Energy of Surges.—S. Franck. (*E.T.Z.*, 10th Feb. 1938, Vol. 59, No. 6, p. 150: summary only.)

1779. Remarks on the Paper by G. Simpson & F. J. Scrase: "The Distribution of Electricity in Thunderclouds" [Remarks on Temperature: Temperature in a True Thundercloud is always above the Freezing-Point of Water: No Difficulty in Application of Wilson's Theory].—B. Walter. (*Ann. der Physik*, Series 5, No. 2, Vol. 31, 1938, pp. 177–180.) *See* 3605 of 1937.

1780. Photographic Study of Lightning [Unusual Results in New Mexico during 1936].—R. E. Holzer, E. J. Workman, & L. B. Snoddy. (*Journ. of App. Phys.*, Feb. 1938, Vol. 9, No. 2, pp. 134–138.)

1781. Progressive Lightning: IV—The Discharge Mechanism.—B. F. J. Schonland. (*Proc. Roy. Soc.*, Series A, 7th Jan. 1938, Vol. 164, No. 916, pp. 132–150.) For previous parts *see* 424 of February, and for a summary of Part V *see* 1317 of April.

1782. Discussion on "Lightning."—B. L. Goodlet. (*Journ. I.E.E.*, Feb. 1938, Vol. 82, No. 494, pp. 209–213.) *See* 3249 of 1937.

1783. The 9th Meeting of the International High-Voltage Conference—CIGRE [including Summaries of Papers on Lightning Processes and Protection].—(*E.T.Z.*, 17th March 1938, Vol. 59, No. 11, pp. 289–294.)

1784. A New Lightning Arrester [Gap with Radioactive Substance].—Philips Company. (*Engineer*, 11th Feb. 1938, Vol. 165, pp. 172–173.)

1785. The Removal of Electric Charges by Means of an Intense Air Jet.—O. Yadoff. (*Comptes Rendus*, 14th Feb. 1938, Vol. 206, No. 7, pp. 510–512.)

1786. Positive-Point to Plane Discharge in Air at Atmospheric Pressure [Current/Voltage Characteristics: Minimum Gap at which Stable Corona will Flow].—A. F. Kip. (*Phys. Review*, 15th Jan. 1938, Series 2, Vol. 53, No. 2, p. 210: abstract only.)

1787. Cosmic Radiation & Electrical Conductivity in the Stratosphere [Rejection of Theory of Direct Proportionality of Cosmic Ray Intensity and Electrical Conductivity].—O. H. Gish & K. L. Sherman. (*Phys. Review*, 1st March 1938, Vol. 53, No 5, p. 434.)

1788. The Ionisation Balance in the Atmosphere and the Amount of Radium Emanation.—Clay & Dey. (*Physica*, March 1938, Vol. 5, No. 3, pp. 125–128: in English.)

1789. Remarks on the Photochemistry of the Earth's Atmosphere (The Origin of Free Oxygen and the Photochemical Formation of Organic Materials).—W. Groth & H. Suess. (*Naturwiss.*, 4th Feb. 1938, Vol. 26, No. 5, p. 77.)

1790. An Impedance Magnetometer [for exploring Earth's Field: Variation of Impedance of Nickel-Iron Wire measured by Bridge Arrangement].—E. P. Harrison & H. Rowe. (*Proc. Phys. Soc.*, March 1938, Vol. 50, Part 2, pp. 176–184.)

PROPERTIES OF CIRCUITS

1791. High-Frequency Characteristics of High Resistances [of Grid-Leak Type: Causes of Decrease in Effective Resistance as Frequency increases (Stray Capacity is Chief Cause): Methods for Reducing this Decrease (and the Effectiveness of Parallel-Plate Electrodes at Ends: Removal of Residual Films on Inner Surface)].—T. Akahira & M. Kamazawa. (*Electrot. Journ.*, Tokyo, Feb. 1938, Vol. 2, No. 2, p. 48.)

1792. Qualitative Theory of Iron-Cored Chokes pre-magnetised with Direct Current [for Forced Sinusoidal Induction Variation: Magnetic Rectification: Induction Overtones].—T. Wasserrab. (*Arch. f. Elektrot.*, 10th Dec. 1937, Vol. 31, No. 12, pp. 814–821.)

1793. The Transients of an Inductively Shunted Electric Transmission Line, with Special Reference to the Impulse Transmission in Selective-Calling Telephone Systems.—S. Ekelöf. (*Ericsson Technics*, Nos. 5 & 6, 1937, pp. 107–158 & 161–205.)

1794. Double-Action Electronic Relay.—Viti. (*Alta Frequenza*, Feb. 1938, Vol. 7, No. 2, pp. 113–115.) Modification, using an "acorn" pentode, of the circuit dealt with in 1315 of 1937.

1795. On the Operating Time of a Relay when the Relationship between the Magnetic Flux and the Current is Non-Linear.—N. A. Livshits. (*Izvestiya Elektroprom. Slab. Toka*, No. 12, 1937, pp. 39–44.)

1796. The Stability and Performance of the Single "Rectified-Reaction" Stage [Relay-Operating Circuit as used, *e.g.*, in Voice-Frequency Signalling: Theoretical and Experimental Analysis: Occurrence of True "Trigger" and Hysteresis Effects when Device is Biased-Back beyond Cut-Off: etc.].—F. C. Williams & A. Fairweather: Harris. (*P.O. Elec. Eng. Journ.*, Jan. 1938, Vol. 30, Part 4, pp. 294–303.) For Harris's original paper *see* 1933 Abstracts, p. 113, l-h column.

1797. Amplifier Expansion Circuits.—Nadell. (*See* 1910.)

1798. Cathode Phase Inversion.—Schmitt. (*See* 2024.)

1799. Correspondence on "Distortion in Negative-Feedback Amplifiers."—Scroggie: Marinesco. (*Wireless Engineer*, Feb. 1938, Vol. 15, No. 173, p. 91.) Criticism of Marinesco's letter referred to in 890 of March.

1800. A Note on Negative Feedback [Derivation of Series Expressions for Output Voltage].—A. C. Bartlett. (*Wireless Engineer*, Feb. 1938, Vol. 15, No. 173, pp. 90–91.)

1801. Frequency Discrimination by Inverse Feedback [as Substitute for Filters: giving Sharply Discriminating Low-Pass, Band-Pass, High-Pass, or Band-Elimination Characteristics through Resistance-Capacity-Coupled Amplifiers with only Resistive and Capacitive Elements in Feedback Circuit: with Design Procedure].—G. H. Fritzinger. (*Proc. Inst. Rad. Eng.*, Feb. 1938, Vol. 26, No. 2, pp. 207–225 [wrongly headed Jan. 1938, No. 1]).

1802. A New Type of Selective Circuit and Some Applications [Use of Inverse Feedback to produce Sharply Selective Circuits: with the Advantage (particularly at Low Frequencies) of Tuning by Resistance-Adjustment: Wide Tuning-Range while maintaining Selectivity Curve which is Constant Percentage Function of Tuned Frequency: a Novel Type of Analyser: Oscillator with Unusually Pure Sinusoidal Wave-Form: etc.].—H. H. Scott. (*Proc. Inst. Rad. Eng.*, Feb. 1938, Vol. 26, No. 2, pp. 226–235.)

1803. The Reactive Filter and Its Application to Wave-Form Analysis [Principle proved useful over Range 35 c/s–2 Mc/s: Selectivity of Same Order as Crystal: Continuously Variable over Very Wide Frequency Range: Other Advantages].—R. M. Barnard. (*Elec. Communication*, Oct. 1937, Vol. 16, No. 2, pp. 158–173.)

1804. Theory and Design of a New Electric Wave Separator [with Various Applications, *e.g.* Multiple-Carrier Systems, Receiving or Transmitting: Comparison with Brandt's "Shunting" Filters].—S. Chiba. (*Nippon Elec. Comm. Eng.*, Dec. 1937, No. 8, pp. 522–529.) The full paper, a summary of which was referred to in 857 of March. For Brandt's paper *see* 2937 of 1936.

1805. Some Properties of a Symmetrical Non-Dissipative Four-Pole Network terminated Symmetrically [Treatment by Use of Two New Vectors, with Possible Further Uses: the "All-Suppressive" Feedback and Amplifilter Circuits].—Y. Kikuti & T. Hayasaka. (*Nippon Elec. Comm. Eng.*, Dec. 1937, No. 8, pp. 511–516.)

1806. Short-Wave Filters composed of Lines.—Mizuhasi. (*See* 1878.)

1807. Discussion on "Transmission Lines at Very High Radio Frequencies."—Reukema. (*See* 1829.)

1808. Impedance and Energy Relations in Electrical Networks [van der Pol's New Theorem (3251 of 1937) obtained as Limiting Case of a General Relationship: a Further Theorem for Networks of Pure Reactances].—H. W. Bode. (*Physica*, March 1938, Vol. 5, No. 3, pp. 143–144: in English.)

1809. Relaxation Methods [of obtaining Approximate Solutions of Systems of Linear Simultaneous Equations] applied to Engineering Problems: II—Basic Theory, with Applications to Surveying and to Electrical Networks, and an Extension to Gyrostatic Systems [with Numerical Example of Partition of Alternating Current in an Inductive Network].—A. N. Black & R. V. Southwell. (*Proc. Roy. Soc.*, Series A, 18th Feb. 1938, Vol. 164, No. 919, pp. 447–467.)

1810. Graphical Solution of Impedances in Parallel, *and* Graphical Solution of Multiple Resistance and Reactance.—J. L. Clarke: E. C. Goodale. (*Elec. Engineering*, Jan. & Feb. 1938, Vol. 57, Nos. 1 & 2, pp. 41–42 & 82–83.) *Cf.* Böning, 1340 of April.

1811. Note on the Frequency Behaviour of Reactances [Derivation of Feldtkeller's Results (with Application to Fluctuation Noise Voltages in Reactive Networks, and to Amplification Factor of Triode) direct from Reactance Theorem].—H. Salinger: Feldtkeller. (*Proc. Inst. Rad. Eng.*, Jan. 1938, Vol. 26, No. 1, pp. 107–111.) For Feldtkeller's paper *see* 1309 of 1937.

1812. Losses in A.F. Coils [with Set of Formulae, derived from Accumulated Experimental Data, for Selection of Low-Loss Inductances for Tuned Circuits and Filters].—L. B Arguimbau. (*Communications*, Feb. 1938, Vol. 18, No. 2, pp. 10 and 35, 36.)

1813. Tuned Impedance of Intermediate-Frequency Transformers [with Chart].—(*Communications*, Feb. 1938, Vol. 18, No. 2, pp. 12–13.)

1814. Crystal Channel Filters for the Cable Carrier System.—C. E. Lane. (*Bell S. Tech. Journ.*, Jan. 1938, Vol. 17, No. 1 pp. 125–136.)

1815. Electro-Mechanical Filter of Variable Frequency.—Fubini-Ghiron. (*See* 1929.)

1816. **Differential Negative Resistances and Relaxation Oscillators.**—N. Carrara. (*Alta Frequenza*, March 1938, Vol. 7, No. 3, pp. 148–171.)

Definition of "ordinary" negative resistance and "differential" negative resistance: the work of van der Pol and of Rocard: theory and experimental confirmation of stability and instability conditions of circuits composed of differential negative resistances and positive resistances. Elementary theory and experimental confirmation of behaviour of relaxation oscillators of various types, and their synchronisation by external voltages: formulae for oscillation period and interval of synchronisation.

1817. **The Impedance Concept and Its Application to Problems of Reflection, Refraction, Shielding, and Power Absorption.**—Schelkunoff. (*See* 1740.)

TRANSMISSION

1818. **Some Problems of Hyperfrequency Technique** [Generation of Micro-Waves: Frequency Stabilisation: Use of Micro-Wave Valve to reduce Damping of a 3000 Mc/s Receiver, by "Negative Leakance" Effect when Close to Oscillation Threshold].—A. G. Clavier & E. Rostas. (*Elec. Communication*, Jan. 1938, Vol. 16, No. 3, pp. 254–262.)

1819. **Production of Centimetre and Millimetre Waves in the Magnetron.**—H. Richter. (*Hochf:tech. u. Elek:akus.*, Jan. 1938, Vol. 51, No. 1, pp. 10–17.)

Transit-time oscillations in two-slit magnetrons are described; Fig. 1 shows various constructions for the electrodes, of which type *c* was chosen for the experiments. A bolometer of type Fig. 2c was used for energy measurements. The oscillation region is shown in Fig. 3; Fig. 4 gives a section through this region for a given anode voltage, showing anode current, intensity and wavelength as a function of the magnetic field. Fig. 5 shows the maximum oscillation energy for optimum values of magnetic field, current and voltage, Fig. 6 the intensity distribution of some valves of various anode diameters, Fig. 7 the oscillation energy as a function of the angle between the magnetic field and the symmetry axis of the electrodes. Fig. 7c shows that for optimum adjustment of other conditions, the adjustment of this angle is not so critical over a wide range. Fig. 9 gives the h.f. energy and efficiency of several valves as a function of wavelength.

Voltage modulation is discussed in § IV3; Fig. 10 shows the power and wavelength radiated from a dipole as a function of the anode voltage, Fig. 11 modulation characteristics for various output emissions, with (I) a Lecher system with fixed tuning, (II) subsequent tuning of the Lecher system. Fig. 12 shows d.c. resistance and modulation impedance for various output emissions.

The construction of generators to give the shortest possible wavelength is described in § IV4; Fig. 13 shows a valve for wavelengths from 2 cm to 4.9 mm, Fig. 14 its anode current as a function of the magnetic field for (a) symmetrical and (b) asymmetrical filament position. The latter gave shorter effective anode radius and no noticeable decrease in energy. Fig. 15 shows the valves themselves, of which tabulated data are given.

1820. **Production of Dwarf Waves with the Magnetron Emitter.**—O. H. Groos. (*Hochf:tech. u. Elek:akus.*, Feb. 1938, Vol. 51, No. 2, pp. 37–43.)

The writer describes the conditions under which he has succeeded in producing dwarf waves of half the wavelength of the shortest so-called "transit time" waves (first-order oscillations of wavelength given by eqns. 1, 2). The experimental valves which were found to produce them are shown in Fig. 1 (electrode scheme Fig 1a); numerical data for their construction are given. They contain a built-in oscillating circuit and are connected galvanically to a Lecher parallel-wire system. Experimental tables and curves are given of the variation of the wavelength and intensity of the oscillations with anode voltage (Fig. 2), magnetic field (Fig. 3), external tuning with constant working conditions (Fig. 4), external tuning when the working conditions are simultaneously adjusted to their optimum values (Fig. 5). A second type of valve with smaller anode diameter gave waves of length down to about 5 cm. Data are also given of the influence of the angle between magnetic field and valve axis (§ II 2f), the distance between the anode cylinder axis and the sealing-in point of the connections to the Lecher system (§ II 2g), and the effect of the emission (or space-charge) on the oscillation intensity (§ II 2h). Discussion of the results leads to the conclusion that the dwarf waves arise as coupling waves between the natural electron oscillation and the natural oscillation of the oscillating circuit inside the valve. Consideration of the energy balance between the single electron groups (§ II 4, Fig. 6) shows that a steady state of uniform control of the electrons to produce dwarf waves is only possible in slit-anode magnetrons. Fig. 7 illustrates the potential distribution in a two-slit magnetron and the path of an electron.

1821. **Potential Distribution in the Magnetron** [Probe Measurements].—W. Engbert. (*Hochf:tech. u. Elek:akus.*, Feb. 1938, Vol. 51, No. 2, pp. 44–52.)

A probe is first described which is designed to have always the potential of the point at which a measurement is being made, and to determine the potential distribution in the presence of any degree of space charge. Its circuit is shown in Fig. 1 and the detailed construction of the magnetron-probe system in Fig. 2. The magnetron consists simply of an incandescent filament and a coaxial, un-slit anode cylinder. The probe is raised, by an external source, to the same potential as the point between cathode and anode where it is situated; it then is attracted neither to cathode nor anode and is observed to be at rest. The potential of the point can thus be read directly on the voltmeter attached to the probe; stationary fields only can be measured. The action of the probe was tested by measuring potential distributions with linear electron paths (Fig. 3). Measured curves of the potential distribution in a magnetron are given for the cases when the magnetic field prevents the electrons from reaching the anode (Fig. 5), when the filament is not central (Fig. 6), for various values of filament current and anode voltage with constant magnetic field (Figs. 7b, 8). The results are discussed (§ IV) with calculations of the space charges (Fig. 9, electron paths ; Fig. 10, graphical determination of the potential distribution). It is found that electrons moving in circles give rise to a much lower space potential than when the electron paths are linear and space-charge saturation occurs. The conditions for the occurrence of this low potential are discussed.

1822. THE STATICALLY NEGATIVE CHARACTERISTIC OF THE HABANN VALVE.—A. Lerbs & K. Lämmchen. (*Hochf:tech. u. Elek:akus.*, Feb. 1938, Vol. 51, No. 2, pp. 60–66.)

To explain the negative resistance of the Habann valve, the electron paths are investigated graphically (§ II) ; three types of path are found (Figs. 2, 3, 4) and the conditions giving rise to them described. Their combination to produce a negative characteristic is discussed with reference to a measured characteristic (§ IIc). § III describes an experimental investigation of the static characteristics (Fig. 6, arrangement of anode leads ; Fig. 7, magnetron characteristics for different angles between filament and magnetic field ; Fig. 8, currents and negative characteristics for various saturation currents ; Figs. 9, 10, envelope of characteristics ; Fig. 11, diagrams for the calculation of the ratio (magnetic field)/(critical magnetic field). The unfavourable effect of space charge is explained by considering the electron paths. The principles of the action of two- and four-slit anodes are found to be the same.

1823. MECHANISM OF SPLIT-ANODE MAGNETRON OSCILLATIONS [and the Difference between Dynatron and B-Type Oscillations : Micro-Wave Oscillations hitherto called Dynatron Type (or Habann Oscillations) are really B Type].—K. Okabe. (*Nippon Elec. Comm. Eng.*, Dec. 1937, No. 8, pp. 530–535.) *Cf.* Habann, 1356 of April. For a previous paper on B-type oscillations *see* 3266 of 1937.

1824. ON THE CONDUCTOR-CORE-COIL OSCILLATOR. —Ohtaka & Mano. (*Nippon Elec. Comm. Eng.*, Dec. 1937, No. 8, pp. 540–544.) *See* also 897 of March.

1825. FREQUENCY CHANGING WITH THE OCTODE [" Influence " Effect of Second Space Charge: an " Influence " Oscillator giving Ultra-Short-Waves down to 1.5 Metres].—Lukàcs. (*See* 1858.)

1826. A B-TYPE [Three-] PARALLEL-WIRE OSCILLATOR [giving Back-Coupled, Electron, or Dynatron Type Oscillations : Relations between Wavelengths].—S. Ohtaka. (*Electrot. Journ.*, Tokyo, March 1938, Vol. 2, No. 3, p. 70.) For the " B-type " circuit *see* 996 of 1935.

1827. THE DYNATRON AS AN ULTRA-SHORT-WAVE GENERATOR.—H. H. Meinke. (*Hochf : tech. u. Elek : akus.*, Feb. 1938, Vol. 51, No. 2, pp. 52-59.)

Continuation of work referred to in 4054 of 1937. In § I the necessary circuit conditions for ultra-short-wave generation are discussed ; Fig. 1 shows a circuit for measuring CR/L, Fig. 2 measured CR/L–curves for the dynatron emitter. It is found that the emitter must be suitably choked (circuit Fig. 3) and the voltage between cathode and grid must be constant, between cathode and anode must have the full a.c. value, if oscillations are to build up and the emitter is to work normally. Fig. 5 shows the scheme for an ultra-short-wave emitter ; determination of the optimum choke value is illustrated by the curves of Fig. 4. The wavelengths reached under various conditions are given in Table 1. In § III the change of steepness of the characteristic due to electron inertia is discussed theoretically, in § IV the change of the oscillation characteristics by electron inertia (Fig. 8). Figs. 7, 9 give curves of the starting and stopping conditions, Fig. 10 oscillation characteristics for a wavelength of 7 m. Figs. 11, 12 give circuits for oscillations with a Lecher-wire system. Experimental results with it are described.

1828. A RESONANCE PHENOMENON OBSERVED IN THE ELECTRONIC OSCILLATIONS OF TRIODES [Ultra-High-Frequency Oscillations at Several Frequencies determined by Natural Frequency of a Spiral Grid and Its Supports].—E. Pierret & C. Biguenet. (*Comptes Rendus*, 21st Feb. 1938, Vol. 206, No. 8, pp. 596-598.)

1829. DISCUSSION ON " TRANSMISSION LINES AT VERY HIGH RADIO FREQUENCIES " [particularly the Questions of Radiation from Coaxial Pair shorted with Conducting Discs, Comparative Values of Q for Lines and Crystals (Mason finds Crystal Q is Independent of Frequency), etc.]—Reukema. (*Elec. Engineering*, Feb. 1938, Vol. 57, No. 2, Supp. pp. 104–107.) Reukema's results (3635 of 1937) are criticised by Schelkunoff, Hansell & Carter, and Mason. The writer defends them with vigour.

1830. PAPERS ON QUARTZ OSCILLATORS [for Ultra-Short Waves].—Uda & others. (*See* 1993 & 1994.)

1831. AMPLITUDE MODULATION FOR MICRO-WAVES [free from Frequency Modulation : Acorn Modulating Valves across Lecher Wire System].—S. Nakamura. (*Electrot. Journ.*, Tokyo, Feb. 1938, Vol. 2, No. 2, p. 47.) Giving " a modulation of nearly 100% perfection " with two acorn valves in parallel. The insertion of one of these valves at every potential node is also being tried ; in addition, modulation by sealing the Lecher wire into a vacuum tube and changing the degree of ionisation will be tested.

1832. A UNIQUE METHOD OF MODULATION FOR HIGH-FIDELITY TELEVISION TRANSMITTERS. —W. N. Parker. (*Proc. Inst. Rad. Eng.*, Feb. 1938, Vol. 26, No. 2, pp. 132–133 : summary only.) *See* also 1098 of March.

1833. A CRYSTAL-CONTROLLED " PACK " TRANSMITTER [for 37.6 Mc/s : Stability allowing Superheterodyne Reception : Total Weight 35 lb].—D. Langham. (*Communications*, Feb. 1938, Vol. 18, No. 2, pp. 18–19.)

1834. A Pack Set for 200 and 300 Megacycles [Completely Portable Ultra-Short-Wave Transmitters using Acorn Valves and Resonant-Line Oscillator Circuits].—L. C. Sigmon. (*QST*, March 1938, Vol. 22, No. 3, pp. 40–42 and 88, 90.)

1835. Police Transmitter [30–42 Mc/s: Power Output 38 Watts (Modulated): with "Signal Boosting" Amplifier Circuit permitting Unusually High Modulation Percentage].—Bell Tel. Laboratories. (*Communications*, Feb. 1938, Vol. 18, No. 2, pp. 22 and 41.)

1836. Correction to "An Analysis of the Self-Excitation of a Piezo-Dynatron Oscillator."—K'yandski. (*Izvestiya Elektroprom. Slab. Toka*, No. 12, 1937, p. 64.) *See* 1365 of April.

1837. Differential Negative Resistances and Relaxation Oscillators [Theory and Experiment].—Carrara. (*See* 1816.)

1838. Frequency Modulation in Short-Wave Radio-Telegraphy [may be More, certainly is Not Less, effective against Fading than Amplitude Modulation, and eliminates Interference due to Excessive Width of Frequency Band].—S. Amari. (*Nippon Elec. Comm. Eng.*, Dec. 1937, No. 8, pp. 550-553.) A summary was dealt with in 2921 of 1937.

1839. The Modulator Bridge [German "Ring Modulator," using Inertia-less Reversing Switch in form of "Ring" of Four Rectifiers: giving Suppressed-Carrier Modulation with Special Properties: Application to Multiple Concentric-Cable Telephony, Industrial Applications (Humidity Measurement in Paper Mills, etc.), Amplification of Frequency Bands starting with Zero Frequency, etc.].—R. K. Hellmann. (*Electronics*, March 1938, Vol. 11, No. 3, pp. 28–30.) *See* also Walter, 1932 Abstracts, p. 651, and Schmid, 1741 of 1937.

1840. Signalling System [for Multiplex Carrier Working] utilising Resistance Tuning Circuit [for Transmission and Reception: Better Selectivity for Smaller Number of Elements].—Narumi & others. (*Nippon Elec. Comm. Eng.*, Dec. 1937, No. 8, p. 560: summary only.)

1841. An Experimental 5 kW "Doherty" Amplifier.—C. E. Strong & G. G. Samson. (*Elec. Communication*, Jan. 1938, Vol. 16, No. 3, pp. 233–239.)

1842. A Solution to the Tank-Circuit L/C Ratio Problem: Variable-Range Condenser for Multi-Band Transmitters [by modifying a Split-Stator Condenser to give Two Sections].—F. Lester. (*QST*, March 1938, Vol. 22, No. 3, pp. 47–48.)

1843. Protecting the High-Voltage Plate Ammeter [Device mounted at Same General Potential as Meter: Ordinary Fuse Wire melts and releases Spring Contact providing Alternative Path.]—W. E. Groves. (*Electronics*, Feb. 1938, Vol. 11, No. 2, p. 38.)

RECEPTION

1844. The Basic Principles of Super-Regenerative Reception [Experimental Investigation (by Cathode-Ray Oscillograms) and Mathematical Analysis, first for Rectangular and then for Sinusoidal Quench Voltage: Important Effect of Grid-Leak Value, even with Separately Quenched Detector: "Linear" and "Logarithmic" Modes of Operation (and a Receiver with No Direct Plate Voltage: a Receiver with Quench Voltage applied in Grid Circuit): Quench Frequency and Sensitivity: Selectivity: etc.].—F. W. Frink. (*Proc. Inst. Rad. Eng.*, Jan. 1938, Vol. 26, No. 1, pp. 76–106.)

1845. Superheterodyne Reception of Micro-Rays [19 db Improvement of Signal/Noise Ratio compared with Super-Regeneration: Specially suitable for Field-Strength Measurement].—A. H. Reeves & E. H. Ullrich. (*Elec. Communication*, Oct. 1937, Vol. 16, No. 2, pp. 153-157.) A description of 1934 work "of present-day interest in view of the increasing activity in this sphere."

1846. Reduction of Damping of 3000 Mc/s Receiver by "Negative Leakance" of Micro-Wave Valve.—Clavier & Rostas. (*See* 1818.)

1847. Short-Wave Distortion [Influence of Various Types of Fading on Quality of Reproduction].—(*Wireless World*, 10th March 1938, Vol. 42, pp. 215–216.)

1848. Modulation Suppression of a Weak Signal by a Stronger One ["Masking Effect": English "Demodulation": Comprehensive Analytical Treatment: Can only occur if Rectifier Load Circuit is capable of following Potential Variations at Beat-Frequency Rate: etc.].—H. Roder. (*Communications*, Feb. 1938, Vol. 18, No. 2, pp. 14-17 and 45, 46.)

1849. The Mutual Modulation Effect of Electromagnetic Waves in the Ionosphere [Luxembourg Effect: 1936 Prague/Vienna and 1937 Leipzig/Berlin and Leipzig/Zeesen Tests: Variation with Distance and Variation with Time].—J. Grosskopf. (*Hochf:tech. u. Elek:akus.*, Jan. 1938, Vol. 51, No. 1, pp. 18-30.)

From the German State P.O. An earlier series of researches was dealt with in 859 of 1936. The present tests show that as regards variation with distance the results agree satisfactorily with the Bailey & Martyn theory. As regards variation with time, "the generally observed synchronism between the course of the carrier amplitude and that of the modulation amplitude, in a *medium-wave* disturbed transmission, is always to be explained by interference between two or more disturbance-modulated space rays. With constant depths of disturbance-modulation it may be assumed that the interference is occurring between rays which have followed approximately similar paths. Large fluctuations of the depth of disturbance-modulation are caused by interference between rays with very different propagation paths, and by the added action of absorption. With disturbed *long-wave* transmissions the course of the disturbance-modulation indicates its dependence predominantly on absorption fading." In a section on the powers of interference possessed by the interaction effect in general, the writer refers to his paper on the tolerable ratio of interference (1401 of April).

1850. Discussion on "A Review of Radio Interference Investigation" [including a Qualitative Explanation of "External Cross Modulation" by Osterbrock].—Sanford & Weise. (*Elec. Engineering*, Feb. 1938, Vol. 57, No. 2, Supp. pp. 107–110.) *See* 482 of February.

1851. Practical Measurements on Communal-Aerial Installations.—K. Müller & O. Schneider. (*E.T.Z.*, 27th Jan. 1938, Vol. 59, No. 4, p. 100: summary only.)

1852. Tests on the Effects of Interference on Aerial Systems with Screened Down-leads.—Bergtold. (*See* 1879.)

1853. Broadcast Interference produced by Superheterodyne Receivers [Causes and Prevention].—W. Gerber & A. Werthmüller. (*E.T.Z.*, 17th Feb. 1938, Vol. 59, No. 7, pp. 177–178: summary only.)

1854. Electromagnetic [and Electrostatic] Interference from Alternating Current Mains [Tests on Concentric, Twisted and Parallel V.I.R and other Cables, Iron Conduit, etc.].—J. E. R. Constable. (*Journ. Scient. Instr.*, March 1938, Vol. 15, No. 3, p. 107.)

1855. R.F. Interference from Power Circuits: Identifying and Curing Radio Noises.—R. Y. Chapman. (*QST*, March 1938, Vol. 22, No. 3, pp. 49 and 96.)

1856. Arrangement for Interference Elimination by Means of a Compensation Circuit [Signal Voltages, including Interference, led to One Pair of Cathode-Ray-Tube Plates: Interference Voltages alone, 180° Out of Phase, to Another Pair].—F. Hagans. (*Hochf:tech. u. Elek:akus.*, Feb. 1938, Vol. 51, No. 2, p. 74: German Patent 651 618 of 2.4.36.)

The cathode ray, after leaving the deflection zone, is thus "free from the interference": it then falls on a photo-mosaic surface illuminated by two lamps and discharges the strip it passes over. A metallic coating to the tube acts as an anode and leads the impulses (arising from the scanning) to an amplifier.

1857. Novelties in Radio Construction [including Protection against Interference].—M. Adam: de Monge. (*Génie Civil*, 5th March 1938, Vol. 112, No. 10, pp. 206–209.) Particularly the de Monge "antiparasite-valve" arrangement dealt with in 99 of January.

1858. Frequency Changing with the Octode [Second Space Charge, besides giving Multiplicative Mixing, also couples Input and Oscillator Circuits and causes Gain to be dependent on Frequency: Theoretical and Experimental Investigation of this "Influence" (Inductive) Effect: Its Compensation (Small Capacity between 1st and 4th Grids): Parasitic Oscillations, and an "Influence" Oscillator giving Ultra-Short Waves].—E. Lukàcs. (*Wireless World*, 17th March 1938, Vol. 42, pp. 239–240.) From the Tungsram laboratories. For the work of Bakker & de Vries *see* 3411 of 1935 and back references.

1859. Distortion Limiter for Radio Receivers [Two Methods of preventing Overload at First-Audio or Power-Audio Grids at High Volume Levels].—M. L. Levy. (*Electronics*, March 1938, Vol. 11, No. 3, pp. 26–27.)

1860. High-Frequency Characteristics of High Resistances [of Grid-Leak Type].—Akahira & Kamazawa. (*See* 1791.)

1861. Tuned Impedance of Intermediate-Frequency Transformers [with Chart].—(*Communications*, Feb. 1938, Vol. 18, No. 2, pp. 12–13.)

1862. Amplifier Expansion Circuits.—Nadell. (*See* 1910.)

1863. Loudspeaker *versus* Orchestra [Comparison of Measurements on Loudness and Intensity of Programme as heard in Concert Hall and as received by Wireless: and the Question of "Apparent Loudness," Scale Distortion, and "Scaled-Down" Reproduction].—(*Wireless World*, 10th March 1938, Vol. 42, pp. 210–213.) By the writer whose pseudonym is "Cathode Ray."

1864. Europe's Record Broadcasting Year: 3¾ Millions More Licences.—(*World-Radio*, 25th March 1938, Vol. 26, p. 6.)

1865. Faults in Receivers: Peculiarities that Puzzle even the Experts.—(*World-Radio*, 25th March 1938, Vol. 26, p. 11.)

1866. Automatic 1938 [Constructional Details of a Receiver giving 5 Stations by Press-Button Control].—(*Toute la Radio*, March 1938, No. 50, pp. 99–104.)

1867. Push-Button Tuning Systems.—(*Wireless World*, 10th March 1938, Vol. 42, pp. 206–209.)

1868. Variable-Selectivity Superhet [Usual Inadequate Selectivity attributed to Q-Values being Too Small or spoiled by Small Cans, Shunting by Low-Resistance Diode, etc: Remedies giving $Q = 205$: Other Improvements].—McMurdo Silver. (*Electronics*, Feb. 1938, Vol. 11, No. 2, pp. 47, 48, 50.)

1869. The "Infinite Rejection" Principle applied to Image Attenuation: a New Method of Eliminating Images in Superhet Receivers.—K. W. Miles & J. L. A. McLaughlin. (*QST*, March 1938, Vol. 22, No. 3, pp. 20–23 and 98.) For the principle in question *see* 488 of February.

1870. New Ericsson Wireless Sets [Broadcast Receivers and Radiogramophones].—(*Ericsson Review*, No. 4, 1937, pp. 168–171.)

1871. A Braille-Equipped Receiver with Touch-Tuning [Magnetic Brake] for the Blind.—(*Gen. Elec. Review*, Feb. 1938, Vol. 41, No. 2, p. 109.)

1872. Foreign Radio Trade Names and Brands [Summarised Results of U.S.A. Government Survey].—(*Communications*, Feb. 1938, Vol. 18, No. 2, p. 30.)

AERIALS AND AERIAL SYSTEMS

1873. Photographic Recording of Electrical Radiation Fields [from Aerials, Reflectors, etc.] in a Wave-Dead Model Space [without Undesired Reflections from Walls, etc: Experiments in Distilled Water in Double Trough, the Outer Case containing Absorbing Medium: Electric Field scanned by Movable Glow-Lamp Indicator and recorded Photographically].—H. E. Hollmann. (*Naturwiss.*, 11th Feb. 1938, Vol. 26, No. 6, p. 95.)

1874. Forced Electrical Oscillations in a Conductor of Finite Length and Diameter.—A. E. Suzant. (*Journ. of Tech. Phys.* [in Russian], No. 20/21, Vol. 7, 1937, pp. 2018–2040.)

It is pointed out that the current distribution in a vibrator (aerial) is determined by the applied e.m.f. and the conditions governing the propagation of electromagnetic waves in the surrounding medium. An exact theory of the current distribution in a vibrator in a free space is developed, and it is shown that the smaller the diameter of the vibrator and the nearer the frequency of the applied e.m.f. approaches the natural frequency of the vibrator, the more nearly sinusoidal is the current distribution.

1875. Discussion on "The Fading Characteristics of the Top-Loaded WCAU Antenna."—Brown & Leitch. (*See* 1756.)

1876. New Antenna for KDKA extends Service Area ["tenfold": 710-ft Radiator inside Circle of Eight 90-ft Aerials to suppress High-Angle Radiation].—(*Elec. Engineering*, Jan. 1938, Vol. 57, No. 1, p. 39.)

1877. A Method of employing a Common Feeder for Two Short-Wave Antennas [and Its Advantages (including Avoidance of Losses due to Inductive Interference): Tests on JAG and JAE Aerials].—Kato, Mizuhasi, & Huzikura. (*Nippon Elec. Comm. Eng.*, Dec. 1937, No. 8, pp. 545–549.) *See* also 1878, below.

1878. Short-Wave Filters composed of Lines [T, Pi, and Lattice Types: for Transmission of Two Different Frequencies along Single Short-Wave Feeder, Elimination of Harmonics, etc.].—T. Mizuhasi. (*Nippon Elec. Comm. Eng.*, Dec. 1937, No. 8, pp. 558–559: summary only.) *See* also 1877, above. *Cf.* Mihelson, 1066 of 1935.

1879. Tests on the Effects of Interference on Aerial Systems with Screened Downleads [Magnetic, Simultaneous Electric & Magnetic, and Electric Actions: Importance of Magnetic Action—often Neglected].—F. Bergtold. (*Funktech. Monatshefte*, Feb. 1938, No. 2, pp. 36–37.) This magnetic effect is responsible for the fact that earthing often increases the interference and that metal roofs (even when well earthed) and metal aerial stays may introduce interference.

1880. Practical Measurements on Communal-Aerial Installations.—K. Müller & O. Schneider. (*E.T.Z.*, 27th Jan. 1938, Vol. 59, No. 4, p. 100: summary only.)

VALVES AND THERMIONICS

1881. Electron Pump Effect at [Ultra-] High Frequencies [Theory (and Experimental Confirmation) of Phenomenon of Flow of Electron Current to Negative Anode of Triode].—M. R. Gavin. (*Wireless Engineer*, Feb. 1938, Vol. 15, No. 173, pp. 81–83.)

1882. The Characteristic Admittances of Mixing Valves for Frequencies up to 70 Mc/s.—M. J. O. Strutt. (*E.N.T.*, Jan. 1938, Vol. 15, No. 1, pp. 10–17.)

The most important properties of mixing valves, as regards measurement, are described in § I; Fig. 1 shows a circuit in which an octode acts as a self-oscillating mixing valve, Fig. 2 the circuit of a mixing stage containing a hexode and a separate oscillator valve. § II describes the circuit (Fig. 3) for measuring input and output admittance, steepness of heterodyne characteristic (intermediate-frequency anode a.c. divided by h.f. input signal voltage), distortions, whistling tones, oscillation properties and induction effects of mixing valves, up to a frequency of 1.5 Mc/s. § III gives measured data for some mixing valves in common use. The circuit used for admittance measurements up to 70 Mc/s (§ IV, Fig. 5) is in all important points identical with that of Fig. 3, with suitable screening and appropriate dimensions of the circuit elements. § V gives the results of measurements in the short-wave range, § VI measurements of the induction effect for short waves (circuit Fig. 9).

1883. Papers on Magnetron Valves.—(*See* under "Transmission.")

1884. The Variation of Voltage Distribution and of Electron Transit Time in the Space-Charge-Limited Planar Diode [Expression for Inter-Electrode Current, Cathode Field, & Transit Time derived from Simplified Form of Langmuir's Equations].—R. Cockburn. (*Proc. Phys. Soc.*, March 1938, Vol. 50, Part 2, pp. 298–310.)

1885. On the Theory of Space Charge between Parallel Plane Electrodes [Four General Types of Potential Distribution are Possible: Curves for Easy Calculation of Transmitted Current and Transit Time: "Critical-Distance" Valves: Complete Mathematical Treatment].—C. E. Fay, A. L. Samuel, & W. Shockley. (*Bell S. Tech. Journ.*, Jan. 1938, Vol. 17, No. 1, pp. 49–79.) For an independent investigation *see* Salzberg & Haeff, 1428 & 1429 of April.

1886. The Destruction of Electronic Space Charges by Beams of Positive Carriers [Examination of Mechanism of Current Increase in High-Vacuum Valves on Introduction of Small Quantities of Gas].—R. Kienzle. (*See* 1251 of March.)

1887. Frequency Changing with the Octode [and the "Influence" Effect of the Second Space Charge].—Lukàcs. (*See* 1858.)

1888. Discussion on "The Apparent Inter-Electrode Capacitance of a Planar Diode," *and* Discussion on "The Dependence of the Inter-Electrode Capacitances of Valves upon the Operating Conditions."—E. B. Moullin: Iorwerth Jones. (*Journ. I.E.E.*, Feb. 1938, Vol. 82, No. 494, pp. 219–220.) *See* 137 and 138 of January.

1889. Intensity Control of Electron Currents [Calculations, with Relation to Cathode-Ray Tubes and Valves].—A. Recknagel. (*Hochf:tech. u. Elek:akus.*, Feb. 1938, Vol. 51, No. 2, pp. 66–72.)

The intensity control here discussed is that attained by means of electron mirrors, where the electrons are accelerated in front of a positive grid, some of them reflected, and the distribution of the total current among the different electrodes is varied. The effect of the grid must be considered as that of a network of wires (Fig. 1); the theory of electron mirrors must be applied (Fig. 2, electron paths). As the grid voltage is decreased, the electron-opaque boundary regions increase, as in a decreasing optical iris; this is the essence of the control exercised by the grid on the current. It is here investigated by calculating the characteristics (§ II), on the assumption that the secondary space-charge formation has no influence on the potential, *i.e.* that Laplace's equation is valid. § III gives calculations for the case of rotational symmetry, § IV for the case of a plane. Calculated characteristics (Fig. 4, 5) are compared with those found experimentally by Rothe & Kleen (2630 of 1936 & 537 of 1937); the agreement is satisfactory.

1890. Beam Power Tubes [Fundamental Requirements for High-Fidelity Sound Reproduction: General Problem of Power-Valve Design: Analysis of Screen-Grid Valves: Theory and Design of Beam-Power Valves with Space-Charge Suppression of Secondary-Emission Effects: Performance].—O. H. Schade. (*Proc. Inst. Rad. Eng.*, Feb. 1938, Vol. 26, No. 2, pp. 137–181.)

1891. Electron-Multiplier [based on Secondary-Emission Principle, with Caesium Electrodes] as an Electron-Counting Device [Inherent Defects: Thermal Emission of Caesium Surfaces: Leakage Current: Output Capacity: Multiplication Factor: Application to Counting Photons, etc.]—Z. Bay. (*Nature*, 12th Feb. 1938, Vol. 141, p. 284.)

1892. The Influence of the Geometrical Arrangement of Atoms on Secondary Emission [Experiments on Beryllium Films after Heating to Various Temperatures show Change of Secondary Emission after Heating to 750° C, probably due to Change of Arrangement of Atoms].—R. Kollath. (*Naturwiss.*, 28th Jan. 1938, Vol. 26, No. 4, p. 60.)

1893. Experiments on the Mechanism of Emission from a Barium-Oxide Cathode [Emission Constants vary with Temperature].—R. Suhrmann & G. Frühling. (*Naturwiss.*, 18th Feb. 1938, Vol. 7, p. 108.)

1894. On Some Recent Measurements of the Volta Effect, and on the Volta Effect in Alloys.—O. Scarpa: Krüger & Schulz. (*La Ricerca Scient.*, 15th/31st Jan. 1938, Series 2, 9th Year, Vol. 1, No. 1/2, pp. 10–13.) Discussion of the results of Krüger & Schulz (3422 of 1936), doubt as to their conclusions, and stress on the great importance of further research to settle the question.

1895. Foundations for the Calculation of the Heating of Wires and Bars by Conduction Currents or Radiation [with Application to Cathodes, Resistance Wires, Thermoelements, Hot-Wire Meters, Fuses, Thermophones, etc.].—J. Fischer. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 19, 1938, pp. 25–30.)

A later paper (1896, below) deals with the practical application (*see* footnote 26 on p. 30) of these fundamental results. The present work gives the differential equation of the temperature distribution and discusses the calculation of the various constants involved, in relation to the source of heat, the temperature dependence of the constants of the material, and the surface losses.

1896. Stationary and Variable Temperature Distributions along Wires and Bars heated by Conduction Currents or by Radiation.—J. Fischer. (*Zeitschr. f. tech. Phys.*, No. 3, Vol. 19, 1938, pp. 57–63: to be contd.) The paper referred to in 1895 above.

1897. Statistical Mechanics of the Adsorption of Gases at Solid Surfaces [Theory using Method of Partition Functions: Generalised Adsorption Theorem]: *and* The Adsorption of Argon, Nitrogen, and Oxygen on Smooth Platinum Foil at Low Temperatures and Pressures [Measurements].—F. J. Wilkins. (*Proc. Roy. Soc.*, Series A, 18th Feb. 1938, Vol. 164, No. 919, pp. 496–509: pp. 510–531.)

1898. The Component Elements of Thermionic Valves [Transmitting and Receiving: Ideal Requirements of Each, and How Nearly they can be Fulfilled with Available Materials: Comparison of Different Types of Cathode].—L. Piatti. (*L'Elettrotec.*, 25th Jan. 1938, Vol. 25, No. 2, pp. 46–53.)

1899. Co-ordinating the New Tubes [Chart of Characteristics of Newest and Old Voltage Amplifiers, Detectors, and Power Amplifiers].—D. G. Fink. (*Electronics*, March 1938, Vol. 11, No. 3, p. 36.)

DIRECTIONAL WIRELESS

1900. The Ultra-Short-Wave Guide-Ray Beacon and Its Application [Part I—Lorenz U.S.W. Landing Beacon and Practical Results (including Split Beams due to Hangars, Gasometers, etc.): Part II—The Application of the U.S.W. Guide-Ray Beacon for Long-Range Air Navigation (U.S.W. Propagation—Survey of Literature: Field-Strength Curves at Various Heights: Encouraging Tests at Essendon Airport, Australia)]—E. Kramar & W. Hahnemann. (*Proc. Inst. Rad. Eng.*, Jan. 1938, Vol. 26, No. 1, pp. 17-44.)

1901. Reduction of Night [and "Aeroplane"] Error in Radio Direction-Finding Equipment for Aerodromes [and the "Standard-Adcock" Equipment: Results at Norrköping: a Semi-Portable D.F. with Adcock Aerial System].—H. Busignies. (*Elec. Communication*, Jan. 1938, Vol. 16, No. 3, pp. 213–232.)

1902. American Technique for Safety in Aviation [Report on Tour of Investigation].—F. W. Petzel. (*E.T.Z.*, 10th & 17th Feb. 1938, Vol. 59, Nos. 6 & 7, pp. 137–144 & 168–172.)

1903. Automatic Control for Aircraft [by Wireless "Homing" Device].—(*Nature*, 26th Feb. 1938, Vol. 141, p. 364: short note only.)

1904. A Wireless Interferometer [Use of Pair of Spaced Frames for Determination of Spread of Direction of Scattered Rays].—Eckersley. (*See* 1743.)

ACOUSTICS AND AUDIO-FREQUENCIES

1905. Sound Radiation from a Spherical Vibrator [and Application to Radiation Characteristics of Loudspeakers: Determination of Size of Baffle: Possible Extension to Study of Microphone].—A. Hirayama. (*Nippon Elec. Comm. Eng.*, Dec. 1937, No. 8, pp. 536–539.)

1906. Novelties in Radio Construction [including Loudspeakers].—M. Adam. (*Génie Civil*, 5th March 1938, Vol. 112, No. 10, pp. 206–209.)

1907. The Longitudinal Piezoelectric Effect in Rochelle-Salt Crystals.—Cady. (*See* 2000.)

1908. Tracing Loudspeaker Curves [and the Tobe Deutschmann "Audiograph"].—W. N. Weeden. (*Wireless World*, 17th March 1938, Vol. 42, pp. 230–231.)

1909. Loudspeaker *versus* Orchestra.—"Cathode-Ray." (*See* 1863.)

1910. Amplifier Expansion Circuits [Survey of Commercial "Expandor" Circuits for P.A., Gramophone, and other Purposes].—A. Nadell. (*Communications*, Feb. 1938, Vol. 18, No. 2, pp. 11–12 and 39.)

1911. "The Offset-Head Crystal Pickup" [Development of the Exact Formula for Optimum Value of Overhang/Arm-Length Ratio].—D. G. Knapp: Bird & Chorpening. (*Communications*, Feb. 1938, Vol. 18, No. 2, pp. 28-29.) The approximate formula was given in the paper referred to in 2217 of 1937.

1912. HP6A: a Radical Departure in Phonograph Pickup Design [Velocity-Microphone Principles: 30–18 000 c/s flat within ± 3 db, with Needle Pressure of 0.17 oz].—F. V. Hunt & J. A. Pierce. (*Electronics*, March 1938, Vol. 11, No. 3, pp. 9–12.)

1913. Direct Disc Recording [for Immediate Playback: Practical Technique].—C. J. Lebel. (*Electronics*, March 1938, Vol. 11, No. 3, pp. 22–25.)

1914. Sound Recording in the German State Broadcasting Service [with Some Data of Various Methods].—von Braunmühl. (*Funktech. Monatshefte*, Feb. 1938, No. 2, pp. 62–64.)

1915. Some Aspects of Magnetic Recording and Its Application to Broadcasting [including Comparison between "D.P." (Double Pole) and "S.P.I." (Single Pole and Idle Pole) Systems, and Details of B.B.C. Maida Vale Installation].—A. E. Barrett & C. J. F. Tweed. (*Journ. I.E.E.*, March 1938, Vol. 82, No. 495, pp. 265–285: Discussion pp. 285–288.)

Among other points in the Discussion, Stenning refers to the American method of perpendicular magnetisation (2999 of 1937—Hickman): the authors consider the results inferior to those obtained with the systems described. Pawley suggests the possibility of negative feedback from a reproducing head into the recording (or auxiliary recording) head, to cancel some non-linear distortion and noise.

1916. On the "Flachentreue" ["Surface Accuracy": a New Quantity, of which "Resolving Power" is a Special Case] of Photographic Papers.—A. Narath. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 19, 1938, pp. 36-41.) Of importance in sound-on-film work and in astronomical and spectrophotometric investigations.

1917. The Transmission of Wide Frequency Bands along Cables [for Television and Multiplex Carrier Telephony: Short Survey of Theory and Practice].—G. Straimer. (*Funktech. Monatshefte*, Feb. 1938, No. 2, pp. 57–62: to be contd.)

1918. CORRECTION TO "A METHOD FOR IMPROVING ARTICULATION IN A COMMUNICATION CHANNEL SUBJECTED TO INTERFERENCE."—Vysotski & Tetelbaum. (*Izvestiya Elektroprom. Slab. Toka*, No. 1, 1938, p. 61.) *See* 567 of February.

1919. PAPERS ON COAXIAL CABLES.—(*See* under "Phototelegraphy & Television.")

1920. SOME CONSIDERATIONS ON TOTAL REVERBERATION [of Electrically Coupled Rooms].—L. D. Rosenberg. (*Journ. of Tech. Phys.* [in Russian], No. 22, Vol. 7, 1937, pp. 2166–2167.)

The existing theory of reverberation for the case of two electrically coupled rooms, *i.e.* when a loudspeaker in one is controlled by a microphone in the other, is based on the assumption that the reverberation constants of the primary and secondary rooms contribute in a similar manner to the total reverberation. It is pointed out that this assumption is not always correct.

1921. THE APPLICATION OF THE THEORY OF NETWORKS TO THE ACOUSTICS OF BUILDINGS.—A. I. Belov. (*Journ. Tech. Phys.* [in Russian], No. 20/21, Vol. 7, 1937, pp. 2041–2048.) The propagation of sound in a room and the transmission of sound from one room to another are examined by analogy with the electrical theory of networks.

1922. ABSORPTION OF SOUND BY POROUS WALLS [leading to 10–20 Microns as Optimum Pore Radius for Absorption for Layers 1–2 cm thick].—A. F. Monna. (*Physica*, March 1938, Vol. 5, No. 3, pp. 129-142: in English.)

1923. SOUND DAMPING BY AIR RESONATORS IN BUILDING CONSTRUCTION [Theory and Experimental Confirmation].—W. Zeller. (*Akustische Zeitschr.*, Jan. 1938, Vol. 3, No. 1, pp. 32–35.) For use where methods depending on porous materials or resonant plates are not applicable. A perforated plate is fixed so as to leave an air-gap between itself and the fixed wall: the columns of air in the holes act as incompressible masses, the air in the gap as a spring.

1924. NOTE ON THE WHISPERING GALLERY OF ST. PAUL'S CATHEDRAL.—A. E. Bate. (*Proc. Phys. Soc.*, March 1938, Vol. 50, Part 2, pp. 293–297.)

1925. A RAPID LOGARITHMIC RECORDER.—A. Hugony. (*Alta Frequenza*, Feb. 1938, Vol. 7, No. 2, pp. 84–112.)

Inadequate volume range and recording speed of previous logarithmic recorders for the purposes of measurements on musical instruments and supersonic investigations on architectural models: a new type with a h.f. carrier-wave amplifier (tuned to 442 kc/s) with automatic gain control, the carrier wave being modulated, by the phenomenon to be recorded, through a semi-symmetrical opposed-phase modulator. The range is 80 db, and a cathode-ray oscillograph does the recording.

1926. A NEW TYPE OF ANALYSER USING INVERSE FEEDBACK TO GIVE BAND WIDTH WHICH IS A CONSTANT PERCENTAGE OF THE TUNED FREQUENCY.—Scott. (*See* 1802.)

1927. A METHOD OF HARMONIC ANALYSIS [at Acoustic Frequencies: Dynamometer Principle using String Electrometer: Analysis of Series of Electrical Impulses]: A STUDY OF THE ROTATIONAL FREQUENCIES OF SCREW PROPELLERS.—G. F. Partridge. (*Phil. Mag.*, March 1938, Series 7, Vol. 25, No. 168, pp. 505–539.)

1928. THE REACTIVE FILTER AND ITS APPLICATION TO WAVE-FORM ANALYSIS.—Barnard. (*See* 1803.)

1929. ELECTRO-MECHANICAL FILTER OF VARIABLE FREQUENCY [Precision Instrument on Vibrating Blade Principle: Continuously Variable Adjustment: Resonance Curve as given by a Circuit of $Q = 100–250$]—E. Fubini-Ghiron. (*Alta Frequenza*, Feb. 1938, Vol. 7, No. 2, pp. 138–144.) The adjustment gives something like a 7 : 1 range (*e.g.* 80–600 c/s).

1930. INTERNAL FRICTION IN SOLIDS: II—GENERAL THEORY OF THERMOELASTIC INTERNAL FRICTION [including Effect of Stress Inhomogeneity in Transverse Vibrations of Reeds and Wires, Effect of Imperfections, etc.]: III—EXPERIMENTAL DEMONSTRATION OF THERMOELASTIC INTERNAL FRICTION [of Copper Reed in Frequency Range 50–4000 c/s].—C. Zener: Zener, Otis, & Nuckolls. (*Phys. Review*, 1st Jan. 1938, Series 2, Vol. 53, No. 1, pp. 90–99: 100–101.) For I *see* 4154 of 1937.

1931. A VERSATILE LEVEL METER [Range − 65 to + 12 db, 6 mW Zero].—F. Schumann. (*Electronics*, March 1938, Vol. 11, No. 3, pp. 13–14 and 65.)

1932. NEW TRANSMISSION MEASURING SYSTEMS FOR TELEPHONE CIRCUIT MAINTENANCE.—F. H. Best. (*Bell S. Tech. Journ.*, Jan. 1938, Vol. 17, No. 1, pp. 1–16.)

1933. INVESTIGATIONS ON FREE SOUND-SENSITIVE FLAMES [and Their Usefulness in Acoustic Research].—P. E. Schiller. (*Akustische Zeitschr.*, Jan. 1938, Vol. 3, No. 1, pp. 36–45.)

1934. DESIGN OF AUDIO-FREQUENCY INPUT AND INTERVALVE TRANSFORMERS [Practical Method reducing Labour of Calculations to a Minimum and taking account of Use of Modern Core Materials].—J. G. Story. (*Wireless Engineer*, Feb. 1938, Vol. 15, No. 173, pp. 69–80.) From the B.B.C. Research Department.

1935. LOSSES IN A.F. COILS.—Arguimbau. (*See* 1812.)

1936. ABSORPTION MEASUREMENTS ON THE EAR DRUM WITH THE "SCHUSTER BRIDGE" [Tubes-and-Diaphragm Device for measuring Acoustic Impedance].—E. Waetzmann. (*Akustische Zeitschr.*, Jan. 1938, Vol. 3, No. 1, pp. 1–6.)

1937. The Existence of the Faculty of Distance Estimation in Hearing [Experimental Investigation].—G. von Békésy. (*Akustische Zeitschr.*, Jan. 1938, Vol. 3, No. 1, pp. 21–31.)

1938. Organ Pipes and Edge Tones [Edge Tones responsible for Vibration Initiation: Explanation of Initial Phenomena].—G. B. Brown. (*Nature*, 1st Jan. 1938, Vol. 141, pp. 11–13.)

1939. Sound Transitions in the Organ [Different in Different Registers: Great Importance for Musical Quality of Organ: Interdependence on Room Acoustics: etc.].—Trendelenburg, Thienhaus, & Franz. (*Akustische Zeitschr.*, Jan. 1938, Vol. 3, No. 1, pp. 7–20.) Using the octave-filter oscillograph technique dealt with in 1473 of 1936. For a previous paper *see* 553 of February.

1940. The Influence of the Material of Metal Organ Pipes on Their Tonal Qualities.—W. Lottermoser. (*Akustische Zeitschr.*, Jan. 1938, Vol. 3, No. 1, pp. 63–64.)

1941. Electronic Music Instruments [Recent Developments, including Violin and Guitar].—(*Communications*, Feb. 1938, Vol. 18, No. 2, pp. 33, 34, 35.)

1942. The Phenomena of Self-Oscillation in Acoustics [Investigation in connection with Violent Oscillations in a Water System].—Y. Rocard. (*Rev. d'Acoustique*, May/July 1937, Vol. 6, Fasc. 3/4, pp. 102–117.)

1943. A Method of Photographing Airscrew Sound-Waves.—W. F. Hilton. (*Proc. Roy. Soc.*, Series A, 4th Feb. 1938, Vol. 164, No. 918, p. S 19: abstract only.)

1944. Diffraction of Light by Supersonic Waves in Solids [Explanation of Experiments with Glasses showing Two Diffraction Patterns of Different Spacings].—N. S. N. Nath & H. Mueller. (*Nature*, 1st Jan. 1938, Vol. 141, p. 37.) Development of theory referred to in 4181 of 1937 to explain effect referred to in 2253 of 1936 (Hiedemann & Hoesch).

1945. The Sono-Radio Buoy.—McIlwraith: Cowie. (*Hydrographic Review*, Nov. 1937, Vol. 14, No. 2, pp. 258–261: pp. 261–263.)

PHOTOTELEGRAPHY AND TELEVISION

1946. On a Light-Storing Television Camera with Semiconducting Dielectric [in place of the Insulating Layer between Photosensitive Mosaic Surface and Its Backing Electrode in the Iconoscope].—G. Krawinkel, W. Kronjäger, & H. Salow. (*Zeitschr. f. tech. Phys.*, No. 3, Vol. 19, 1938, pp. 63–73.)

Authors' summary:—To eliminate the difficulties in "collecting" the signal-producing photoelectrons in an electron-camera with insulating dielectric [due to the weakness of the "collecting field" between the mosaic and the collector electrode, owing to the electron-bombarded insulated mosaic taking up a potential not very different from that of the collector] it was sought to improve the conditions for "collecting" by providing a bias potential through a dielectric of suitable conductivity. Consideration of the two limiting cases—complete insulation and metallic conductivity—suggests that there should be an optimum semiconducting value. This value, together with the working process of image production and the correct working conditions, was determined first by tests on a special tube in which a single point of the mosaic layer was represented on a magnified scale, and secondly by tests on working, semiconductor-type electron cameras. Both methods agreed in giving, for a storing time $T = 1/25$ second, a value of $\tau = 0.1–0.2$ second for the optimum time constant of the semiconductor.

A theoretical analysis shows also the existence of a maximum of light-sensitivity, dependent on the time constants of the storing capacity; the optimum is given by the relation $T/\tau = \text{const.}$ For a flat-plate storing capacity there is, moreover, an invariability of sensitivity to geometrical changes of the storing capacity.

With such semiconductor electron cameras the photoemission and secondary-emission characteristics can be plotted. These show that about 40–60% of all the photoelectrons liberated take part in the production of the image signal. It is thus possible to produce images when the illumination on the signal plate is 1–2 lux, corresponding to $1.5–2.5 \times 10^{-7}$ lumen/picture-element [a footnote on p. 70 states that it has later been possible to reduce the illumination intensity necessary for satisfactory transmission to 0.5 lux, corresponding to 7.5×10^{-8} lumen/picture-element: this means that about 80–100% of all the liberated photoelectrons are collected from the layer].

1947. Contribution to the Explanation of the Action of the Electron-Beam Picture Scanner.—W. Heimann & K. Wemheuer. (*E.N.T.*, Jan. 1938, Vol. 15, No. 1, pp. 1–9.)

"An experimental determination is described of the time-variation of the voltage on an illuminated and on an unilluminated mosaic element of the photocathode in a cathode-ray picture scanner during and after scanning by an electron beam." The fundamental construction of the scanner is shown in Fig. 1a; only the mosaic photocathode was altered for the experiments, as shown in Fig. 1b. The experimental method is described; Figs. 2–4 give oscillograms of the voltage across the mosaic element under test during a scanning operation, for various beam currents and illuminations. Fig. 6 shows how the peak voltage and the equilibrium potential of an unilluminated and illuminated element vary with the beam current. The experimental results are explained by the occurrence of secondary electrons and the flow back of electrons from the space charge between mosaic cathode and collecting electrode. Photoelectrons also play a part in the case of the illuminated element. Calculations are given to explain the motion and distribution of the electrons and space charge (Fig. 10, potential distribution). "The investigations lead to the view that control of potential by the photocurrents is the cause of the action of the cathode-ray picture scanner, rather than the collector action hitherto assumed."

1948. TELEVISION WITHOUT SYNC SIGNALS [at Du Mont Laboratories: Frame Frequency 15 (Halved Band-Width) with Flicker removed by 4 : 1 Interlacing: Synchronising Signals dispensed with by transmitting Wave-Forms of Vertical and Horizontal Scanning Voltages produced by Transmitter Sweep-Voltage Generator].—Du Mont. (*Electronics*, March 1938, Vol. 11, No. 3, pp. 33–34 and 68.) "It is true that one-half the information is transmitted in a given time, but except for very rapid motion in the picture the effect is the same as though 30 complete frames were transmitted."

1949. TELEVISION IMAGES: AN ANALYSIS OF THEIR ESSENTIAL QUALITIES [especially from Photometric Standpoint: Contrast, Range, Brightness, Definition, Size, Presentation, Colour, Flicker: Methods of Measurement, etc.]—L. C. Jesty & G. T. Winch. (*Journ. Television Soc.*, Dec. 1937, Vol. 2, Part 9, pp. 316–334.)

1950. INTERLACED SCANNING [Advantages: Causes of Fogged Image: "Rhythmic-Unrhythmic" Scanning: "Definition Multiplication" by "Invisible Offsetting": etc.].—U. A. Sanabria. (*Journ. Television Soc.*, Dec. 1937, Vol. 2, Part 9, pp. 313–315.)

1951. A METHOD FOR JUDGING THE LINEARITY WITH TIME, AND THE FLY-BACK VELOCITY, OF THE RAY DEFLECTION IN OSCILLOGRAPH AND TELEVISION CATHODE-RAY TUBES.—H. Bödeker. (*Funktech. Monatshefte*, Feb. 1938, No. 2, Supp. pp. 9–10.) Including a "Kallirotron" circuit (using a single ACH1 multiple valve) for generating the rectangular-wave-form time markings employed in the method.

1952. PARAGRAPHS ON TELEVISION SYNCHRONISING [Bad Effect of Too Strong a Synchronising Signal: Advantages of Suggested Narrow Vertical Synchronising Impulse: Perfect Interlacing and Synchronisation obtained with Field Strength of 500 Microvolts].—J. R. Duncan. (*Electronics*, Feb. 1938, Vol. 11, No. 2, p. 51).

1953. A UNIVERSAL TEST UNIT FOR THE STUDY OF TELEVISION IMAGES [Combination of Sweep Circuits, Video Amplifier, and "Monotron" or other Image-Signal Generator Tube].—M. P. Wilder. (*QST*, March 1938, Vol. 22, No. 3, pp. 37–39.) Smaller, cheaper versions of the Burnett "Monoscope" (1097 of March) are the "Monotron" and the "Phasmajector."

1954. TWO-WAY TELEVISION OVER LINES: IDEAS WHICH ARE ALSO BEING CONSIDERED IN AMERICA [Abolition of Semi-Dark Cabin by Use of Iconoscope instead of Exploring-Ray Scanning: etc.].—(*Funktech. Monatshefte*, Feb. 1938, No. 2, Supp. p. 12.)

1955. TELEVISION IN COLOUR: DEMONSTRATION OF BAIRD 120-LINE MECHANICAL SCANNING SYSTEM AT DOMINION THEATRE.—(*Electrician*, 18th Feb. 1938, Vol. 120, p. 197.)

1956. TELEVISION AT THE BERLIN RADIO EXHIBITION, 1937.—E. H. Traub. (*Journ. Television Soc.*, Dec. 1937, Vol. 2, Part 9, pp 289–297.)

1957. SOME CONSIDERATIONS IN THE DESIGN OF THE MURPHY TELEVISION RECEIVER.—K. S. Davies. (*Journ. Television Soc.*, Dec. 1937, Vol. 2, Part 9, pp. 299–305.)

1958. APPLICATIONS OF THE MODULATING ELECTRODE OF TELEVISION CATHODE-RAY TUBES IN INVESTIGATIONS OF THE WAVE-FORM OF ATMOSPHERICS, *and* AN APERIODIC AMPLIFIER FOR THE SAME PURPOSE.—Webster. (*See* 1774 & 1775.)

1959. THE TECHNICAL REALISATION OF A LIGHT SOURCE OF UNIFORM ENERGY IN THE REGION OF VISIBLE WAVELENGTHS.—M. von Ardenne. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 19, 1938, pp. 41–43.)

Description of a series-produced apparatus, on the principles outlined in a previous paper (615 of February), using a number of screens of different fluorescent materials excited by ultra-violet light, and giving together a radiation uniform within ± 12% over the range 460–660 $m\mu$. A luxmeter combined with a control arrangement for the exciter lamp ensures also an intensity constant with time.

1960. BRIGHTNESS MEASUREMENTS ON ZINC-SULPHIDE SCREENS EXCITED BY CATHODE RAYS [Measured Curves for Variation of Anode Voltage and Screen Current, for High Voltages and Currents: ZnS on Metal and Glass Screens: "Raster" Distortions due to Charges on Screen].—K. Scherer & R. Rübsaat. (*Arch. f. Elektrot.*, 10th Dec. 1937, Vol. 31, No. 12, pp. 821–826.)

1961 STUDIES ON PHOSPHORESCENT ZINC SULFIDE [with Controlled Method of Preparation and Objective Measurement Methods, with View to obtaining Correlation between Various Factors, *e.g.* between Luminous Properties, Composition, and Heat Treatment].—W. H. Byler. (*Journ. Am. Chem. Soc.*, March 1938, Vol. 60, No. 3, pp. 632–639.)

Among other results, "the total initial phosphorescence intensity was found to be greater after an intermediate period of excitation than after either shorter or longer periods." A theory of phosphorescence is outlined as a result of the work.

1962. THE EFFECT OF TEMPERATURE ON THE EXCITATION OF COLOUR CENTRES [in Alkali Halide Crystals: explained by Shortened Life of Certain Crystal Centres at High Temperatures].—H. Pick. (*Ann. der Physik*, Series 5, No. 4, Vol. 31, 1938, pp. 365–376.)

1963. SUMMARISING REPORT ON ELECTRON CONDUCTIVITY AND PHOTOCHEMICAL PHENOMENA IN ALKALI HALIDE CRYSTALS [Optical Properties : Photoelectric Currents in Crystals : Thermally-Produced Electron Currents : Photochemical Phenomena].— R. W. Pohl. (*Physik. Zeitschr.*, 1st Jan. 1938, Vol. 39, No. 1, pp. 36–54.) For the papers by Pohl and his collaborators, here summarised, *see*, for example, 3084 of 1937.

1964. MAGNETIC DOUBLE REFRACTION OF ORGANIC LIQUIDS AND THEIR VAPOURS [including Experiments on Benzol and Nitrobenzol : Kerr Constant, etc.].—H. König. (*Ann. der Physik*, Series 5, No. 4, Vol. 31, 1938, pp. 289–314.)

1965. KERR EFFECT IN LIQUID & SOLID CO_2.— L. H. Borchert. (*Physik. Zeitschr.*, 15th Feb. 1938, Vol. 39, No. 4, pp. 156–166.)

1966. THE OPTICAL PROPERTIES OF POLAROID [Latest Improved Product] FOR VISIBLE LIGHT.—M. Grabau. (*Journ. Opt. Soc. Am.*, Dec. 1937, Vol. 27, No. 12, pp. 420–424.)

1967. ALUMINISED MIRRORS [as used in Television Receivers, etc.].—C. Sykes. (*Met.-Vickers Gazette*, March 1938, Vol. 17, No. 299, pp. 227–228.)

1968. PAPERS ON OPTICAL GLASS.—Tillyer & others. (*Journ. Opt. Soc. Am.*, Jan. 1938, Vol. 28, No. 1, pp. 1–17.)

1969. THE MEASUREMENT OF LONG FOCAL DISTANCES [where Usual Methods fail].— H. Schulz. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 19, 1938, pp. 34–36.)

1970. AN OPTICAL PARADOX [in connection with Colour Correction and the Variation of Focal Length with Wavelength].—M. Herzberger. (*Journ. Opt. Soc. Am.*, Jan. 1938, Vol. 28, No. 1, pp. 23–26.)

1971. A UNIQUE METHOD OF MODULATION FOR HIGH-FIDELITY TELEVISION TRANSMITTERS. —W. N. Parker. (*Proc. Inst. Rad. Eng.*, Feb. 1938, Vol. 26, No. 2, pp. 132–133 : summary only.) *See* also 1098 of March.

1972. THE TRANSMISSION OF WIDE FREQUENCY BANDS ALONG CABLES [for Television and Multiplex Carrier Telephony : Short Survey of Theory and Practice].—G. Straimer. (*Funktech. Monatshefte*, Feb. 1938, No. 2, pp. 57–62 : to be contd.)

1973. THE LONDON-BIRMINGHAM COAXIAL CABLE SYSTEM : PART II—DESCRIPTION OF THE REPEATERS AND TERMINAL EQUIPMENT.— A. H. Mumford. (*P.O. Elec. Eng. Journ.*, Jan. 1938, Vol. 30, Part 4, pp. 270–283.) For Part I see 215 of January. Part III, in the April issue, will give particulars of the cable itself and the results of the over-all tests.

1974. DEVELOPMENT OF COAXIAL CABLES FOR TELEVISION [in England, Germany, & America : Use for Multi-Telephone Channels : Arrangement of Repeaters].—(*Nature*, 12th March 1938, Vol. 141, pp. 482–483.)

1975. PICTURE TRANSMISSION USING " TIME MODULATION " [Author's Systems using (a) Gas-Filled Triode, and (b) Oscillograph Vibrator]. —M. Kobayashi. (*Elec. Communication*, Oct. 1937, Vol. 16, No. 2, pp. 144–152.)

1976. WIRELESS PICTURE TRANSMISSION BETWEEN BERLIN AND TOKYO [including Measures to reduce Effects of Synchronous and Selective Fadings : Space Diversity and Frequency Diversity Systems : Amplitude Modulation : Time Modulation : etc.].—T. Amisima & M. Kobayashi. (*Nippon Elec. Comm. Eng.*, Dec. 1937, No. 8, pp. 499–510.)

1977. FADING- AND ECHO-PHENOMENA IN THE PROPAGATION OF RADIO PICTURES, AND THEIR ELIMINATION [" Pulse Transmission " System].—E. Hudec. (*E.N.T.*, Dec. 1937, Vol. 14, No. 12, pp. 388–408.)

Known methods of sending and receiving radio pictures are first described, with special reference (§ 1) to Hudec's time-modulation apparatus (Fig. 2 ; 4189 of 1937) with the demodulation circuit (Fig. 4) and short-wave emitter (Fig. 5). Reception arrangements are given in § 2 (Figs. 6–9 ; 635 of February). § 3 deals with known methods for elimination of fading and their applicability to radio pictures ; diversity receiving systems with several recorders (§ 3a) and one recorder (§ 3b ; Beverage, Peterson, Moore, 1931 Abstracts, pp. 382–383 and p. 385), transmission on several frequencies (§ 3c), and multiple reception on different aerials (§ 3d ; Fig. 13, summation apparatus), are discussed.

A new pulse transmission method is described in § 4 ; reference is made (§ 4a) to possible propagation paths *via* the ionosphere. The writer assumes that the waves which travel along the two geometrically shortest paths (Figs. 15a, b) are those which normally arrive with greatest amplitude and that fading phenomena are explicable by interference between these two waves. The pulse method consists in using only the waves which have travelled along the shortest path ; the whole telegraphic signal is not passed to the receiver but only its beginning and end (or one of these) which are combined in the receiver (Fig. 19). Electrical differentiation can be used for transmission of the ends only of the signal (Figs. 17, 18). Tests of this interpretation of fading phenomena (§ 4c, Figs. 21–27), with echo disturbances (§ 4d), the transmission of short signals (Fig. 24) as compared with long ones (§ 4e), variable propagation of the waves taking the shortest path (§ 4f) (which is smoothed out by using several receivers simultaneously), are discussed. The pulse method of transmission (§ 4g) employs the time-modulation apparatus of Fig. 2 ; Fig. 28 shows the reception circuit for producing a cross-" raster," Fig. 29 the composition of the signals at the receiver. Fig. 30 illustrates synchronisation control at the receiver, which may be supervised by a cathode-ray tube. The pulse method allows the depth of blackening of the picture to be correctly adjusted at the receiver.

1978. The Secondary Electron Emission from Complex Rubidium and Potassium Cathodes.—P. V. Timofeev & A. I. Pyatnitski. (*Journ. of Tech. Phys.* [in Russian], No. 22, Vol. 7, 1937, pp. 2138–2144.)

Report on an experimental investigation continuing the work carried out with caesium-oxygen cathodes (1050 *bis* of 1937). The tubes used in these experiments (Figs. 1 & 2) have three electrodes—a cathode *K* (source of primary electrons), an anode *A* (collector), and an emitter (*B*) of secondary electrons. The last electrode is prepared as in the previous investigation, by distilling the rubidium or potassium on to a layer of Ag_2O. Some of the curves obtained during these experiments are shown, and the following conclusions are reached :—(1) the secondary emission is lower than from caesium cathodes ; (2) it depends on the distribution of particles of the alkali metal in the oxide layer of this metal ; and (3) it is determined to a great extent by the temperature of the complex surface.

1979. The Secondary Electron Emission from Gold, Silver, and Platinum covered with Thin Films of Alkali Metals.—A. V. Afanas'eva & P. V. Timofeev. (*Journ. of Tech. Phys.* [in Russian], No. 22, Vol. 7, 1937, pp. 2145–2151.)

Experiments were carried out with three-electrode photocells (Fig. 2) in which the light-sensitive electrodes were prepared by depositing films of various thicknesses of potassium, rubidium, and caesium on layers of gold, silver, and platinum. Observations of the secondary current and of the photocurrent were made for various conditions, and a number of experimental curves so obtained are shown. The main conclusions reached are as follows :—(1) the secondary emission from thin films of alkali metals increases with the increase of the thickness of the film and passes through a maximum ; (2) this increase is small in comparison with the increase of the photocurrent ; and (3) the secondary emission from alkali metals (thick layers) is lower than that from pure gold, silver, and platinum.

1980. Secondary Emission of Electrons from Sodium Films on Tantalum.—P. L. Copeland. (*Phys. Review*, 15th Feb. 1938, Vol. 53, No. 4, p. 328 : abstract only.)

1981. Papers on Secondary Emission.—(*See* also under " Valves & Thermionics.")

1982. The Energy Distribution of Photoelectrons from Sodium.—A. G. Hill. (*Phys. Review*, 15th Jan. 1938, Series 2, Vol. 53, No. 2, pp. 184–193.)

The retarding potential method with spherical electrodes was used to determine the total energy distribution functions for photoelectrons emitted from evaporated sodium surfaces. The results did not agree fully with calculated curves unless a selectively transmitting surface field was assumed. Computations of the spectral distribution function also gave unsatisfactory agreement. " It is concluded that the frequency dependence of the quantum absorption probability and the energy dependence of the barrier transmission probability differ from the image field predictions " on account of " the practical impossibility of producing an 'ideal' surface of Na."

1983. Fatigue of Caesium Photocathode [Fatigue produced by White Light is mainly caused by Short Wavelengths—3000–6000 A.U : Change in Sensitivity is Greatest in Same Region].—Y. Moriya. (*Electrot. Journ.*, Tokyo, Feb. 1938, Vol. 2, No. 2, p. 47.)

1984. The " Drift [or " Initial "] Effect " in Selenium Photovoltaic Cells [Decrease (sometimes Increase—German " Creep Effect ") of Photocurrent during Initial Stage of Illumination : Survey of Published Work : Experimental Investigation—*Not* a Fatigue Phenomenon—Sign of Change depends on Wavelength—Disappearance for a Certain Wavelength—Temperature Dependence : etc.].—Elvegård, Lindroth, & Larsson. (*Journ. Opt. Soc. Am.*, Feb. 1938, Vol. 28, No. 2, pp. 33–35.)

1985. Resistance in Selenium Photovoltaic Cells [and Its Dependence on Current Intensity and on Temperature].—Elvegård, Lindroth, & Larsson. (*Journ. Opt. Soc. Am.*, Feb. 1938, Vol. 28, No. 2, pp. 36–39.)

1986. The Vectorial Photoelectric Effect in Barrier-Layer Cells [Curves showing Difference in Effect of Light Polarised in and perpendicular to Plane of Incidence].—R. G. Wilson. (*Phys. Review*, 1st Feb. 1938, Series 2, Vol. 53, No. 3, p. 264.)

1987. The Galena Light Detector [Experiments showing Existence of Inertia-Free Voltage on Illumination of Various Galena/Point Contacts, frequently accompanied by Thermovoltage : Measured Curves of Current, Voltage, Effect of Bias, Frequency and Temperature Variation, Spectral Distribution, Size of Active Spots on Crystal, etc.].—F. Fischer, B. Gudden, & M. Treu. (*Physik. Zeitschr.*, 1st Feb. 1938, Vol. 39, No. 3, pp. 127–134.)

1988. The Photoelectric Sensitisation of Aluminium [by Hydrogen Glow Discharge : is dependent on Time of Discharge and Pressure of Hydrogen].—L. P. Thein. (*Phys. Review*, 15th Feb. 1938, Vol. 53, No. 4, pp. 287–292.)

1989. A Note on the Theory of Photoconductivity [Primary Photoelectric Current in Solids may be expected to tend to Zero as Temperature is Lowered : Certain Impurities may Prevent this].—N. F. Mott. (*Proc. Phys. Soc.*, March 1938, Vol. 50, Part 2, pp. 196–200.)

1990. The Electric Spark as a Photo-Ionising Light Source [Measurements of Number of Electrons emitted from Electrode under Spark Illumination : Variation with Spark Voltage, Discharge Capacity, Electrode Material, and Distance between Spark Gap and Measuring Electrode : Bearing of Auto-Photoeffect of Gas Discharge on Its Starting Conditions].—A. Wallraff & E. Horst. (*Arch. f. Elektrot.*, 10th Dec. 1937, Vol. 31, No. 12, pp. 789–798.)

1991. THE LOGOMETRIC METHOD OF PHOTOELECTRIC MEASUREMENTS.—M. M. Sliozberg. (*Journ. of Tech. Phys.* [in Russian], No. 22, Vol. 7, 1937, pp. 2152–2156.)

Errors in photoelectric measurements due to variations in the intensity of the light source used as a standard may be eliminated by using two photoelectric cells, each connected to one of the two coils of a logometer. This measures the ratio of the two currents, and hence of the light falling on the two cells, and so renders the measurements effectively independent of the absolute intensity of the light source. For the writer's work on the photoelectric method of measuring a.c. currents and voltages *see* 1107 of March.

1992. WAVE FUNCTIONS AND PERMEABILITIES [to a Stream of Light Particles] FOR A NEW TYPE OF POTENTIAL BARRIER [admitting of Exact Solution of Quantum Wave Equation].—R. P. Bell. (*Phil. Mag.*, March 1938, Series 7, Vol. 25, No. 168, pp. 488–491.)

MEASUREMENTS AND STANDARDS

1993. CRYSTAL CONTROL FOR ULTRA-SHORT WAVES [Experiments on X, Y, R', and R-Cut Quartz, Thickness gradually Reduced: R-Cut (Best) 0.05 mm Thick gave Fundamental 5.9 m, but was Fragile: Promising Results with Third-Harmonic Oscillation].—Uda, Ishida, & others. (*Electrot. Journ.*, Tokyo, Feb. 1938, Vol. 2, No. 2, p. 46.) *See* also 1994, below.

1994. QUARTZ OSCILLATOR USING 3RD-HARMONIC THICKNESS VIBRATION [for Ultra-Short Waves: Satisfactory Practical Results].—S. Uda, M. Ishida, & others. (*Electrot. Journ.*, Tokyo, March 1938, Vol. 2, No. 3, p. 71.) The question whether this plan is better in practice than the use of the fundamental vibration (*see*, for example, 1993, above, and 1130 of March) remains to be decided.

1995. CRYSTAL MONITOR FOR CHECKING [Ultra-Short-Wave] POLICE RADIO.—L. E. Kulberg. (*Electronics*, Feb. 1938, Vol. 11, No. 2, pp. 38 and 40 . . . 44.)

1996. A METHOD FOR DETERMINING THE ELASTIC CONSTANTS [from Radial Piezoelectric or Magnetostrictive Oscillations: Experiments with Tourmalin, Quartz, Nickel].—F. Khol. (*Zeitschr. f. Physik*, No. 3/4, Vol. 108, 1938, pp. 225–231.)

1997. ELECTRICAL MEASUREMENTS ON PIEZO-CRYSTALS [Mechanical Method (Motor-Driven Condenser and Ink-Writer): Relaxation-Oscillation Method with C-R Oscillograph: Intermediate Method using Mirror Instrument].—H. Jacobs & W. Scholz. (*Lorenz-Berichte*, Dec. 1937, No. 4, pp. 158–162.)

1998. ATTENUATION OF PIEZOELECTRIC OSCILLATIONS [Decrease of Attenuation with Falling Temperature to Constant Value at − 100° C].—W. Bosshard & G. Busch. (*Zeitschr. f. Physik*, No. 3/4, Vol. 108, 1938, pp. 195–199.) An abbreviated version was dealt with in 1585 of April.

1999. FURTHER STUDY OF X-RAY DIFFRACTION IN QUARTZ [Piezoelectric Oscillations of the Quartz Crystal have No Effect on Transmitted X-Ray Energies].—G. W. Fox & J. R. Frederick. (*Phys. Review*, 15th Jan. 1938, Series 2, Vol. 53, No. 2, pp. 135–136.) Correction of work referred to in 3188 of 1935: *see* also 300 of 1937.

2000. THE LONGITUDINAL PIEZOELECTRIC EFFECT IN ROCHELLE-SALT CRYSTALS [is Maximum for a Certain Cut: Theory: Experiments on Plates of This Cut in Various Applications: Static, Acoustic, Resonator, and Supersonic Tests].—W. G. Cady. (*Proc. Phys. Soc.*, 1st Nov. 1937, Vol. 49, Part 6, No. 276, pp. 646–653.)

2001. INTERNAL FRICTION IN SOLIDS [and the Vibration of Reeds].—Zener & others. (*See* 1930.)

2002. A MODIFICATION OF WAVEMETERS FOR ULTRA-HIGH FREQUENCIES [Increased Quickness and Accuracy by connecting Detector Circuit near Current Antinode (contrary to Usual Practice), giving Reduced Damping of Tuning Circuit].—T. Hashimoto. (*Electrot. Journ.*, Tokyo, March 1938, Vol. 2, No. 3, p. 70.)

2003. ABSORPTION WAVEMETER [15–20 000 m with 16 Coils: Discrimination 0.03%].—Gambrell Radio. (*Journ. Scient. Instr.*, March 1938, Vol. 15, No. 3, p. 110.)

2004. FREQUENCY MEASUREMENT [at the B.B.C. Tatsfield Station].—H. V. Griffiths. (*World-Radio*, 11th & 18th March 1938, Vol. 26, pp. 12–13 & 12–13.)

2005. PRECISE MEASUREMENTS OF ELECTROMAGNETIC FIELDS [for Aerial Research, etc., rather than for Surveys: Equipment giving Results within 1% for Field Strengths above 3 mV/m at Broadcast Frequencies].—H. G. Smith. (*Proc. Inst. Rad. Eng.*, Jan. 1938, Vol. 26, No. 1, pp. 45–54.)

2006. SUPERHETERODYNE RECEPTION OF MICRO-RAYS [particularly for Field-Strength Measurement].—Reeves & Ullrich. (*See* 1845.)

2007. NEW METHOD OF MEASURING MAGNETIC FIELD [2 cm Wire String stretched in Field and vibrated by 800 c/s Buzzer Current: Back-E.M.F. amplified and measured].—T. Okuda & H. Kawamura. (*Electrot. Journ.*, Tokyo, March 1938, Vol. 2, No. 3, p. 72.) "Very fine results have been obtained with this method."

2008. MEASUREMENT OF MINUTE CHANGES [0.0005%] OF CAPACITANCE AND INDUCTANCE [particularly the Measurement of Temperature Coefficients: Beat Frequency Method].—S. C. Leonard. (*Electronics*, March 1938, Vol. 11, No. 3, pp. 18–21 and 66, 67.) Including some results on the temperature coefficients of various component parts of commercial condensers and inductances.

2009. Direct-Reading Electrostatic Capacity Meter of New Type [applicable to Condensers of Considerable Capacity (*e.g.* 10 Microfarads) even with High Leakage: Independent of Supply Voltage Fluctuations].—T. Hayasi. (*Nippon Elec. Comm. Eng.*, Dec. 1937, No. 8, pp. 557–558.) Utilising the filtering action at the mid-section of a double rectifying system.

2010. A Note on the Measurement of Capacitance by Ballistic Methods [in terms of a Mutual Inductance: Method of Consecutive Comparisons, with Precision of 0.1%].—N. F. Astbury. (*Journ. Scient. Instr.*, March 1938, Vol. 15, No. 3, pp. 94–97.)

2011. Distributed Capacitance Chart [Alignment Chart based on Palermo Equation].—P. H. Massaut: Palermo. (*Electronics*, March 1938, Vol. 11, No. 3, pp. 31–32.) For Palermo's paper *see* 1934 Abstracts, p. 570, l-h column.

2012. Radio-Frequency Output Measurements [Design of Direct-Reading Power Meter for Oscillators and Small Transmitters, using Lamp and "Tungsram" Selenium Photocell].—L. Coulston-Jones. (*Wireless World*, 24th March 1938, Vol. 42, pp. 255–256.)

2013. A New Valve Amplifier for Weak Currents [for Measurement of Direct (*e.g.* Photoelectric) Currents down to 10^{-13} Ampere: Very High Stability: Two Valves, Each Anode connected to One Winding of Differential Galvanometer: Stabilised Indirect Heating from Mains: Current Retroaction].—F. Bedeau & L. Herman. (*Comptes Rendus*, 21st Feb. 1938, Vol. 206, No. 8, pp. 592–594.)

2014. The Logometric Method of Photoelectric Measurements.—Sliozberg. (*See* 1991.)

2015. Electro-Magnetic Instruments with Logarithmic Scales.—L. D. Rosenberg. (*Journ. of Tech. Phys.* [in Russian], No. 22, Vol. 7, 1937, pp. 2157–2165.) The theory of electro-magnetic measuring instruments giving direct indications in accordance with a certain predetermined functional relationship is discussed, and methods are indicated for designing an instrument with a logarithmic scale.

2016. Valve Circuits, with Pointer Instruments, for the Measurement of Coordinates [Direct Measurement of Active and Reactive Components of a Voltage or Current: of Real and Imaginary Components of an Impedance or Admittance: of Phase and of Power].—F. Vecchiacchi. (*L'Elettrotec.*, 25th Feb. 1938, Vol. 25, No. 4, pp. 121–125.)

Two circuits are proposed: the first based on the composition of two oscillations of the same frequency, one the oscillation under test and the other a reference oscillation; and the second based on "controlled electronic rectification"—electronic commutator controlled by a pentode generator of rectangular-wave-form oscillations. Using the second method, the results of a measurement of the real and imaginary components of the a.f. impedance of a parallel resonator circuit are shown in Fig. 11.

2017. The Modulator Bridge ["Ring Modulator"] in Measuring Technique.—Hellmann. (*See* 1839.)

2018. A Bridge for the Comparison of Resistance Standards.—M. Romanowski & M. Picard. (*Comptes Rendus*, 21st Feb. 1938, Vol. 206, No. 8, pp. 594–596.)

2019. A New High-Voltage Meter for Relative and Absolute Measurement [using Electric Manometer].—W. Rogowski & H. Böcker. (*Arch. f. Elektrot.*, 17th Jan. 1938, Vol. 32, No. 1, pp. 44–51.)

2020. Protecting the High-Voltage Plate Ammeter.—Groves. (*See* 1843.)

SUBSIDIARY APPARATUS AND MATERIALS

2021. A Cold-Cathode Oscillograph Discharge Tube of High Power and Low Excitation Voltages [using Auxiliary Discharge, Anticathode, Magnetic Field: Voltage Range 2–20 kV].—Thielen. (*Arch. f. Elektrot.*, 17th Jan. 1938, Vol. 32, No. 1, pp. 38–44.) For similar work *see* Becker, 1501 of 1936 & 1044 of 1937; *also* Rogowski & Malsch, 1933 Abstracts, p. 283, l-h column.

2022. The Instantaneous-Action Cathode-Ray Oscillograph and Its Use [Russian Equipment with Electron Beam created by Aperiodic Impulse Voltage (No D.C. Supply): Special Optical Relay: a Dual-Ray Tube: Oscillogram of a 6.6×10^9 c/s Wave (Discharge of 50 cm Overhead Line): etc.].—Stekolnikov. (*L'Elettrotec.*, 25th Feb. 1938, Vol. 25, No. 4, pp. 132–133: summary only.)

2023. A Method of Simultaneously Projecting Two Periodic Curves on a Cathode-Ray Oscillograph [using Polarised Relay as Two-Way Switch, driven by a Ringing Magneto].—Kennard. (*Journ. Scient. Instr.*, March 1938, Vol. 15, No. 3, p. 106.)

2024. Cathode Phase Inversion [introducing Little Distortion and Considerable Amplification: particularly suitable for Sweep and Deflection Circuits in C-R Oscillography].—Schmitt. (*Journ. Scient. Instr.*, March 1938, Vol. 15, No. 3, pp. 100–101.)

2025. An Aperiodic Amplifier for Investigating the Wave-Form of Atmospherics [by C-R Oscillograph: Independent of Frequency between 50 & 5×10^5 c/s: Push-Pull Device for eliminating Mains Fluctuations].—Webster. (*See* 1775.)

2026. "Die Leuchtmassen und ihre Verwendung" [an Introduction to the Fluorescence and Phosphorescence of Solid Materials: Book Review].—Rupp. (*Angewandte Chemie*, 26th Feb. 1938, Vol. 51, No. 8, p. 123.)

2027. Papers on Phosphorescence and Fluorescence of Zinc Sulphide.—Scherer & Rübsaat: Byler. (*See* 1960 & 1961.)

2028. The Fluorescence of the Divalent Rare Earths: Sequel to the Paper "Discolouration and Luminescence from Becquerel Rays: IV."—Przibram. (*Zeitschr. f. Physik*, No. 9/10, Vol. 107, 1937, pp. 709–712.) For the paper referred to *see* 266 of 1937.

2029. Fluorescence of the Rare Earths [Ultra-Violet Fluorescence of Trivalent Cerium: Fluorescence of Rare Earths in Borax and Phosphorus-Salt Beads].—Gobrecht. (*Ann. der Physik*, Series 5, No. 2, Vol. 31, 1938, pp. 181–186.) For previous work *see* 3124 & 3125 of 1937.

2030. Asymmetric Radiation produced by High Velocity Electrons [Experimental Proof of Existence: Law of Direction of Emission: Fluorescence produced in Glass, Mica, etc., is Small].—Collins & Reiling. (*Phys. Review*, 15th Jan. 1938, Series 2, Vol. 53, No. 2, p. 205: abstract only.)

2031. A Note on the Principle of Least Action in Optics and Electron Optics.—S. Rodda. (*Journ. Television Soc.*, Dec. 1937, Vol. 2, Part 9, p. 298.)

2032. Intensity Control of Electron Currents [Calculations, with Relation to Cathode-Ray Tubes and Valves].—Recknagel. (*See* 1889.)

2033. A New Apparatus for Demonstrating the Diffraction of Electrons [at Paris International Exposition, 1937].—Trillat. (*Elec. Communication*, Oct. 1937, Vol. 16, No. 2, pp. 103–107.)

2034. Electron-Optical Observation of the Transition of α- into β- Zirconium: *and* Lecture-Room Demonstration of Electron-Optical Crystal Patterns.—Burgers & Ploos van Amstel. (*Nature*, 19th Feb. 1938, Vol. 141, p. 330: 26th Feb., p. 370.)

2035. On the Theory of Focusing in the Cyclotron [Effect of Inhomogeneities in Electric and Magnetic Fields], *and* Focusing Actions in the Cyclotron [Calculation of Ion Paths by Iterative Integration].—Rose & Bethe: Wilson. (*Phys. Review*, 15th Jan. 1938, Series 2, Vol. 53, No. 2, p. 206: p. 213: abstracts only.)

2036. A Direct-Reading Diaphragm Vacuum-Meter of High Sensitivity [using Varying Air-Gap between Two Iron-Cored Coils].—Brinkmann. (*E.T.Z.*, 27th Jan. 1938, Vol. 59, No. 4, pp. 98–99: summary only.)

2037. A Grid-Controlled Ionisation [Vacuum] Gauge.—Montgomery & Montgomery. (*Review Scient. Instr.*, Feb. 1938, Vol. 9, No. 2, p. 58.)

2038. On a Modification of Hickman's Distillation [Vacuum] Pump [and the Superiority of "Octoil" over "Apiezon"].—Malter & Marcuvitz. (*Review Scient. Instr.*, March 1938, Vol. 9, No. 3, pp. 92–95.)

2039. Papers on the Calculation of the Heating of Wires and Bars by Conduction Currents or Radiation.—Fischer. (*See* 1895 & 1896.)

2040. Energy Exchange by Electron Collision in Low-Pressure Discharges [Possibility of Calculation of Electron Temperatures and Gradients in Positive Column as Functions of Quantities such as Tube Radius and Gas Pressure].—Mierdel. (*Naturwiss.*, 4th Feb. 1938, Vol. 26, No. 5, p. 79.)

2041. The Excess Temperature in the Dark Space of the Glow Discharge [Theory: Experiment].—Güntherschulze & Bär. (*Zeitschr. f. Physik*, No. 9/10, Vol. 107, 1937, pp. 642–652.)

2042. The Mechanism of Corona Discharge [studied by Cathode-Ray-Oscillograph Comparison of Signals produced in Radio Set by Corona Discharge with Voltages across Resistance in Series with the Point].—Trichel. (*Phys. Review*, 15th Jan. 1938, Series 2, Vol. 53, No. 2, p. 214: abstract only.)

2043. Contribution of the Photoelectric Effect to the Sparking Mechanism in the Noble Gases at High Pressures.—Kruithof & Penning. (*Physica*, March 1938, Vol. 5, No. 3, pp. 203–204: in English.)

2044. Corona Discharge from Needle Point [and the Influence of Needle Angle].—Uenisi. (*Electrot. Journ.*, Tokyo, March 1938, Vol. 2, No. 3, pp. 61–64.)

2045. Characteristics of the Glow/Arc Transition in Mercury Vapour.—Maxfield. (*Phys. Review*, 15th Jan. 1938, Series 2, Vol. 53, No. 2, p. 204: abstract only.)

2046. The Sparking Potential of Mercury Vapour [between Electrodes of Nickel or Steel: Linear Function of Product of Vapour Density × Distance between Electrodes].—Jones & Galloway. (*Proc. Phys. Soc.*, March 1938, Vol. 50, Part 2, pp. 207–212.)

2047. A Mercury-Pool-Anode Rectifier [and Its Advantages: Experimental Development].—Watanabe & others. (*Electrot. Journ.*, Tokyo, Feb. 1938, Vol. 2, No. 2, pp. 41–44.)

2048. Small Iron-Container Rectifiers for Medium Powers.—Siemens & Bauer. (*E.T.Z.*, 27th Jan. 1938, Vol. 59, No. 4, pp. 97–98: summary only.)

2049. SOME REMARKS ON POSITIVE ION SHEATH [in connection with Problem of Back-Arcing in Thyratrons: Effective Area calculated from Langmuir Space-Charge Equation found experimentally to be considerably Smaller than Geometric Area of Sheath Boundary: etc.].—Watanabe & Aoyama. (*Electrot. Journ.*, Tokyo, March 1938, Vol. 2, No. 3, pp. 51–56.)

2050. DEIONISING TIMES OF RECTIFIERS [Factors involved: Measurement: Reduction].—Ostendorf. (*E.T.Z.*, 27th Jan. 1938, Vol. 59, No. 4, pp. 87–89.)

2051. ON THE CONVERSION OF D.C. TO A.C. BY VACUUM TUBES AND THE IMPROVEMENT OF THE EFFICIENCY OF SUCH DEVICES.—Babat. (*Izvestiya Elektroprom. Slab. Toka*, No. 11, 1937, pp. 45–48.)

A convertor tube of the mercury-pool type, called the Herzetron, has been developed in which the arc instead of being concentrated in one point is made by a magnetic field to traverse the mercury pool (which is elongated for that purpose), thus producing a continuously changing path from anode to cathode during the time the arc flows. It is claimed that this imparts to the tube characteristics desirable in a d.c./a.c. convertor.

2052. RESISTANCE MEASUREMENTS ON SELENIUM AT HIGH FIELD-STRENGTHS [up to 110 kV: External and Internal Boundary Layers: Comparison with Measurements on Selenium Barrier-Layer Rectifiers explains Curvature of Rectifier Characteristic as Effect of Barrier Layer and Voltage Variation of Selenium-Layer Resistance].—Henninger. (*Ann. der Physik*, Series 5, No. 4, Vol. 31, 1938, pp. 337–364.)

2053. POINT ACTION IN ELECTROLYTIC VALVE ANODES [Slow Formation of Rough Ta-Anodes due to Point Action: Formation Velocity a Measure of Rigidity of Binding of Electrons in Electrolyte Anions].—Güntherschulze & Betz. (*Zeitschr. f. Physik*, No. 9/10, Vol. 107, 1937, pp. 633–641.)

2054. ANODIC PROPERTIES OF THE ALUMINIUM CELL [supports Theory of Active Film of Colloidal Aluminium Hydroxide].—Pietenpol & Devaney. (*Phys. Review*, 15th Feb. 1938, Vol. 53, No. 4, p. 325: abstract only.)

2055. ON THE NATURE OF THE PROTECTIVE OXIDE FILMS ON ALUMINIUM AND OTHER METALS.—Arkharov. (*Journ. of Tech. Phys.* [in Russian], No. 15, Vol. 7, 1937, pp. 1584–1589.) A survey of experimental data on the subject given by various authors. In conclusion it is suggested that the protective action of oxide films is due to a definite orientation of the crystals in the films.

2056. SUPER-PURITY ALUMINIUM [including Greatly Reduced Leakage of Electrolytic Condensers by Use for Anodes].—(*Light Metals Research*, 26th Feb. 1938, Vol. 6, No. 10, p. 255: summary only.)

2057. THERMAL LOSSES AND THERMAL OPERATING CONDITIONS OF ELECTROLYTIC CONDENSERS.—Morozov. (*Izvestiya Elektroprom. Slab. Toka*, No. 9, 1937, pp. 41–49.)

The thermal operating conditions of electrolytic condensers were investigated by placing the condensers into a calorimeter and observing the variation of resistance of a thin copper wire passed through the inner cylinder of the condenser and connected to a Wheatstone bridge. Condensers of capacities from 2.15 to 4.4 microfarads and a.c. working voltage of 400 volts were used, and observations made with the following voltages applied to the condensers: (a) various a.c. voltages and a constant d.c. voltage; (b) various d.c. voltages and a constant a.c. voltage; and (c) a.c. voltages only. Under these conditions heat runs were made, the leakage currents and angles of loss measured, and capacities of the condensers checked. The results so obtained are shown in a number of tables and discussed, and some practical suggestions are made.

2058. WET ELECTROLYTIC CONDENSERS, *and* THE EFFECT OF THE COMPOSITION OF THE ANODE ALUMINIUM ON THE QUALITY OF ELECTROLYTIC CONDENSERS.—Petrovski. (*Izvestiya Elektroprom. Slab. Toka*, No. 8, 1937, pp. 40–44: No. 1, 1938, pp. 49–56.)

In the first paper a comparison is made between the condensers manufactured in Russia and those manufactured in the U.S.A. (R.C.A. and Solar). From this comparison it is claimed that the Russian condensers are in no way inferior, and in certain respects are even superior, to those of American manufacture.

2059. SOME PHENOMENA TAKING PLACE IN ELECTROLYTIC CONDENSERS.—Nelepets. (*Izvestiya Elektroprom. Slab. Toka*, No. 9, 1937, pp. 50–54.) A certain potential difference can always be observed at the terminals of an electrolytic condenser. This phenomenon was the subject of an experimental investigation, a report of which is here presented.

2060. CRITICISMS OF THE PAPER "ELECTROLYTIC CONDENSERS AND THEIR MANUFACTURE": REPLY.—Mayer-Bartholdt: Bücking. (*E.T.Z.*, 24th Feb. 1938, Vol. 59, No. 8, pp. 207–208.) For Bücking's paper *see* 1574 of 1937.

2061. NOVELTIES IN RADIO CONSTRUCTION [including Insulating Materials, Pre-Set and other Condensers, etc.].—Adam. (*Génie Civil*, 5th March 1938, Vol. 112, No. 10, pp. 206–209.)

2062. THE THERMAL STABILITY OF IMPREGNATING SOLUTIONS FOR PAPER CONDENSERS.—Walther, Inge, & Chelustkina. (*Izvestiya Elektroprom. Slab. Toka*, No. 8, 1937, pp. 53–62.) Experimental investigation of the effect of heating on the properties of paraffin, halowax, and ceresin. For previous work on these condensers *see* 2812 of 1936 and 3874 of 1937: *cf.* also 338 of January.

2063. Improvement of Electrical Characteristics of Kraft Paper by Electrodialysis.—Komagata & others. (*Electrot. Journ.*, Tokyo, March 1938, Vol. 2, No. 3, p. 72.)

2064. Time Constants of High-Voltage Condensers [Measurements up to 75 kV].—Horst. (*Arch. f. Elektrot.*, 10th Dec. 1937, Vol. 31, No. 12, pp. 827–831.)

2065. "Verluste in Kreisplattenkondensatoren bei hoher Frequenz und hoher Spannung" [Losses in Circular-Plate Condensers at High Frequencies and High Voltage: Stuttgart Thesis].—Zechnall. (At Patent Office Library, London: Cat. No. 78 403: 58 pp.)

2066. Experiments to determine the Course of the Current through Dielectrics after Charging [Measurements on Various Dielectrics and Technical Condensers: Representation of Current as Function of Time t^{-m}].—Hippauf & Stein. (*Physik. Zeitschr.*, 15th Jan. 1938, Vol. 39, No. 2, pp. 90–98.)

2067. A Substance of High Dielectric Constant [115 by D.C. Ballistic Method, 33.3 at 50 c/s, and 19.3 at 750 c/s: Breakdown Voltage over 100 kV/cm: Specific Resistance of Order of 10^9 Ohms].—Höfer: Gottesmann. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 19, 1938, p. 51.) A report by Höfer on Viennese measurements on a new material (Gottesmann patent) prepared from hydrocarbons with metallic admixtures, and possessing very special dielectric properties.

2068. "Diffusion und chemische Reaktionen in festen Stoffen" [Book Review].—Jost. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 19, 1938, p. 53.) Including sections on crystals which bear on sinter reactions in (*e.g.*) ceramics.

2069. Insulation Resistance of Ceramic Materials [Very Different Results obtained with D.C. and A.C. Measurements owing to Electrolytic Conductivity: Effect specially marked with Ceramics containing Alkali].—Pfestorf & Richter. (*Physik. Zeitschr.*, 15th Feb. 1938, Vol. 39, No. 4, pp. 141–150.)

2070. Surface Conductivity of Ceresin-Coated Quartz [Worse than That of Plain Quartz].—Hou. (*Review Scient. Instr.*, March 1938, Vol. 9, No. 3, pp. 90–91.)

2071. The Existence of a Vitreous State in Gelatin Gels.—Luyet. (*Phys. Review*, 15th Feb. 1938, Vol. 53, No. 4, p. 323: abstract only.)

2072. Insulating Properties of Air mixed with CCl_4 Vapour [and the Necessity for Avoidance of Surface Creepage].—Suzuki & Nakamura. (*Electrot. Journ.*, Tokyo, March 1938, Vol. 2, No. 3, pp. 70–71.)

2073. "Buna" in Cable Technique, *and* Synthetic Materials in Cable and Conductor Construction.—Roelig: Nowak. (*E.T.Z.*, 17th Feb. 1938, Vol. 59, pp. 172–174: p. 174.) *See* also 1616 of April.

2074. On the Thermoelastics & Structure of Rubber.—Dart & Guth. (*Phys. Review*, 15th Feb. 1938, Vol. 53, No. 4, p. 327: abstract only.)

2075. New Materials in Electrical Technique [from German Raw Materials].—Sachtleben. (*E.T.Z.*, 10th Feb. 1938, Vol. 59, No. 6, pp. 151–153.)

2076. Asphalt Insulating Varnish.—Shimizu & Inai. (*Electrot. Journ.*, Tokyo, Feb. 1938, Vol. 2, No. 2, pp. 36–41.)

2077. "A.S.T.M. Standards on Electrical Insulating Materials" [Book Review].—American Society for Testing Materials. (*Communications*, Feb. 1938, Vol. 18, No. 2, p. 32.)

2078. On the Hygroscopicity of Solid Dielectrics.—Bogoroditski & Friedberg. (*Journ. of Tech. Phys.* [in Russian], No. 12, Vol. 7, 1937, pp. 1292–1303.) Report on an experimental investigation leading to a classification of hygroscopic materials for predetermining the absorption of humidity by a given dielectric. A number of practical suggestions are made.

2079. On the Thermal Break-Down of Solid Dielectrics.—Gaylish. (*Journ. of Tech. Phys.* [in Russian], No. 13, Vol. 7, 1937, pp. 1321–1328.)

At high frequencies the angle of loss of solid dielectrics is not affected by the rising temperature until a certain critical temperature T_c is reached. When T_c is passed the loss angle increases considerably and the dielectric ultimately breaks down. In the present paper formulae are derived determining the maximum safe voltage, corresponding to a temperature just below T_c, for (a) a plate between two electrodes, (b) a hollow cylinder in a radial electric field, and (c) a rod in an electric field parallel to its axis. For each of the above cases the author also determines the break-down voltages corresponding to the equilibrium temperature, *i.e.* when the rate of generation of heat is equal to the rate of dissipation.

2080. The Breakdown of Solid Dielectrics having Various Electrodes deposited on Them.—Vorob'ev & Krasin. (*Journ. of Tech. Phys.* [in Russian], No. 15, Vol. 7, 1937, pp. 1560–1569.)

Coatings of silver, lead, and potassium were deposited on samples of rock salt, ebonite, and mica, and tests were carried out with these samples in vacuum, transformer oil, and xylol. These tests have shown that the break-down voltage of these dielectrics is not affected by the electrodes deposited on them.

2081. A New Psychrometer [Combination of Wet and Dry Thermometers, for Relative Humidity Measurement] with Resistance Thermometers and Differential Crossed-Coil Meter Movement.—Möller. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 19, 1938, pp. 30–34.)

2082. High-Frequency Characteristics of High Resistances [of Grid-Leak Type].—Akahira & Kamazawa. (*See* 1791.)

2083. Solid Resistances [of Carbon & Graphite].—Lepeshinskaya. (*Izvestiya Elektroprom. Slab. Toka*, No. 9, 1937, pp. 33–40.)

An experimental investigation carried out to develop carbon and graphite resistances of small dimensions, high stability, free within wide limits from the effects of load and external conditions, and introducing the smallest amount of noise.

2084. The Electrical Behaviour of Thin Metallic Films Condensed at Low Temperatures [Changes in Resistance due to Agglomeration and Crystallisation].—Mitchell. (*Phys. Review*, 1st Feb. 1938, Series 2, Vol. 53, No. 3, pp. 250–256.)

2085. Structure and Optics of Evaporated Metal Films.—Hass. (*Ann. der Physik*, Series 5, No. 3, Vol. 31, 1938, pp. 245–263.)

2086. Ionic Conductivity in Thin NaCl Films [Measurements: Variation with Film Thickness.]—Boros. (*Zeitschr. f. Physik*, No. 3/4, Vol. 108, 1938, pp. 162–167.)

2087. A Simple Type of Non-Ohmic Resistance for Use with Geiger-Müller Counters [Cosyn's Photocell replaced by Valve with Filament Cold but Illuminated from Outside].—Occhialini. (*Journ. Scient. Instr.*, March 1938, Vol. 15, No. 3, pp. 97–99.)

2088. "Bandförmig unterteilter Hochfrequenzleiter" [Band-Shaped Subdivided H.F. Conductors: Berlin Thesis].—Straimer. (At Patent Office Library, London: Cat. No. 78 369: 32 pp.)

2089. The Mechanical Impulse-Regenerator [designed for Distortionless Repetition of Impulse-Trains in Automatic Telephone Network].—Edwards & Lawrence. (*P.O. Elec. Eng. Journ.*, Jan. 1938, Vol. 30, Part 4, pp. 261–269.)

2090. On the Operating Time of a Relay when the Relationship between the Magnetic Flux and the Current is Non-Linear.—Livshits. (*Izvestiya Elektroprom. Slab. Toka*, No. 12, 1937, pp. 39–44.)

2091. The Calculation of the Ampere-Turns of a Relay operating within Narrow Limits.—Melamed. (*Izvestiya Elektroprom. Slab. Toka*, No. 1, 1938, pp. 24–38.)

2092. Double-Action Electronic Relay.—Viti. (*See* 1794.)

2093. Paper on the "Rectified-Reaction" Relay-Operating Circuit.—Williams & Fairweather. (*See* 1796.)

2094. Ionic Time-Delay Devices [Use of Thyratrons as Time-Delay Relays: with Mathematical and Graphical Analysis], *and* The Application of a Thyratron for Automatic Regulation.—Vartel'ski. (*Izvestiya Elektroprom. Slab. Toka*, No. 12, 1937, pp. 45–56: No. 1, 1938, pp. 39–48.)

2095. A New Vacuum-Tube-Type Automatic Voltage Regulator [with Dry-Cell Voltage Standard replaced by Device using Core Saturation of Transformer: Anti-Hunting Device].—Aoki & Matusita. (*Electrot. Journ.*, Tokyo, March 1938, Vol. 2, No. 3, pp. 56–60.)

2096. Differential Amplifier [Input Stage differentiating, to High Degree of Dependability, a Modulation between Two Ungrounded Points against the Common Modulation of These Points].—Toennies. (*Review Scient. Instr.*, March 1938, Vol. 9, No. 3, pp. 95–97.) For previous amplifiers *see* Offner and Schmitt (1713 and 2759 of 1937).

2097. A Cheap General-Utility Pulse Amplifier [Max. Output, without Overloading, 200 Volts].—Roberts. (*Review Scient. Instr.*, March 1938, Vol. 9, No. 3, p. 98.)

2098. An Amplifier for Geiger Counters.—Alexopoulos & Peristerakis. (*Naturwiss.*, 18th Feb. 1938, Vol. 27, p. 105.)

2099. Electron-Multiplier as an Electron-Counting Device.—Bay. (*See* 1891.)

2100. A Vacuum-Tube Scale-of-Eight Circuit [on Principle similar to Multivibrator, with Direct Coupling by Resistor between Anode and Grid].—Lifschutz & Lawson. (*Phys. Review*, 15th Jan. 1938, Series 2, Vol. 53, No. 2, p. 204: abstract only.)

2101. A Triode Vacuum-Tube Scale-of-Two Circuit [Resolving Time 6.5×10^{-6} Second].—Lifschutz & Lawson. (*Review Scient. Instr.*, March 1938, Vol. 9, No. 3, pp. 83–89.)

2102. New Method of measuring Magnetic Field.—Okuda & Kawamura. (*See* 2007.)

2103. An Impedance Magnetometer [for exploring Earth's Field: Variation of Impedance of Nickel-Iron Wire measured by Bridge Arrangement].—Harrison & Rowe. (*Proc. Phys. Soc.*, March 1938, Vol. 50, Part 2, pp. 176–184.)

2104. Variation of Resistivity of an Electric Conductor in a Magnetic Field.—van Bergen. (*Comptes Rendus*, 21st Feb. 1938, Vol. 206, No. 8, pp. 588–590.)

2105. Production of Uniform Magnetic Fields [by using Appropriate Theoretical Axial Separation of a Pair of Coils].—Stephenson, Ference, & Shaw. (*Phys. Review*, 15th Jan. 1938, Series 2, Vol. 53, No. 2, p. 208: abstract only.)

2106. Qualitative Theory of Iron-Cored Chokes pre-magnetised with Direct Current.—Wasserrab. (*See* 1792.)

2107. Effects of Fringing Flux in Large Magnets.—Howe & Walerstein. (*Review Scient. Instr.*, Feb. 1938, Vol. 9, No. 2, pp. 53–54.)

2108. A New Test Apparatus for Permanent Magnets.—Breitling. (*E.T.Z.*, 27th Jan. 1938, Vol. 59, No. 4, pp. 89–92.)

2109. Recent Developments in Magnetic Materials [including " Oxide " Magnets : Iron & Iron-Silicon Alloys of High Purity : Powder Cores and the Attempt by Dahl & others to replace them by Cold-Worked Iron-Nickel Alloys : etc.]. — Webb. (*Journ. I.E.E.*, March 1938, Vol. 82, No. 495, pp. 303–324.) From the National Physical Laboratory : with 81 literature references.

2110. Production and Properties of the Iron-Nickel-Aluminium Magnet Alloys [Survey and Report on Writers' Investigations].—Messkin & Somin. (*Light Metals Research*, 26th Feb. 1938, Vol. 6, No. 10, p. 250 : summary only.)

2111. Some Observations of Magnetic Viscosity in Iron.—Heaps. (*Phys. Review*, 15th Feb. 1938, Vol. 53, No. 4, p. 334 : abstract only.)

2112. High-Permeability Alloys : Discoveries at Sendai University [Data of " Sendust " and " NC Metal "].—Masumoto : Honda & Masuko. (*Electrician*, 11th March 1938, Vol. 120, p. 314.)

2113. The Effect of Cold Working and Heat Treatment on the Electric and Magnetic Properties of Pure Nickel : I—Drawn Nickel Wire.—Bittel. (*Ann. der Physik*, Series 5, No. 3, Vol. 31, 1938, pp. 219–244.)

2114. Diamagnetism of Cadmium [Measurements : Influence of Cold-Working and Impurities : Bearing of Theory of Paramagnetism of Free Electrons].—Rao & Sriraman. (*Proc. Roy. Soc.*, Series A, 4th Feb. 1938, Vol. 164, No. 918, p. S 20 : abstract only.)

2115. Magnetic Interaction in Heusler Alloy [and Resultant Ferromagnetic Anisotropy : Calculated Numerical Values]—McKeehan. (*Phys. Review*, 15th Jan. 1938, Series 2, Vol. 53, No. 2, p. 199.)

2116. Surface Magnetisation of Cobalt [explained by Model of Magnetised Prisms].—Elmore. (*Phys. Review*, 1st Jan. 1938, Series 2, Vol. 53, No. 1, p. 108 : abstract only.)

2117. The Magnetic Properties of Silver Amalgams [measured by Gouy Method].—Bates & Ireland. (*Proc. Phys. Soc.*, 1st Nov. 1937, Vol. 49, Part 6, No. 276, pp. 642–645.)

STATIONS, DESIGN AND OPERATION

2118. Single Sideband Telephony applied to the Radio Link between the Netherlands and the Netherlands East Indies [Multiplex (Two Telephone—including Broadcasting—and One Telegraph) Short-Wave Service : " Impressively Perfect Result "].—Koomans. (*Proc. Inst. Rad. Eng.*, Feb. 1938, Vol. 26, No. 2, pp. 182–206.) " The general use of the double-sideband method must be considered as obsolete, too much frequency space being occupied and the energy of the carrier and the superfluous sideband being wasted, not only needlessly but even detrimentally."

2119. Radio Channels : Suggested Method of Increasing the Number Available [" A Quantitative Study of Asymmetric-Sideband Broadcasting "]. — Eckersley. (*Electrician*, 4th March 1938, Vol. 120, p. 289.) Summary of I.E.E. paper.

2120. Time-Division Multiplex in Radio-Telegraphic Practice [based on the Baud (Unit Dot Length) : Apparatus used on New York/San-Francisco Service].—Callahan, Mathes, & Kahn. (*Proc. Inst. Rad. Eng.*, Jan. 1938, Vol. 26, No. 1, pp. 55–75.)

2121. High-Frequency Wired Wireless [Carrier Broadcasting over Telephone Network : Fundamental Principles : Apparatus].—Wiessner. (*Lorenz-Berichte*, Dec. 1937, No. 4, pp. 127–155.)

2122. High-Frequency Broadcasting over Telephone Network [and Extensions] in Switzerland [Survey : Advantages and Defects : Investigation of Freedom from Interference : Liability to cause Interference : etc.].—Keller. (*E.T.Z.*, 10th Feb. 1938, Vol. 59, No. 6, pp. 149–150 : summary only.)

2123. Buildings for Broadcast Transmitters.—Williams. (*World-Radio*, 25th March 1938, Vol. 26, pp. 14–15.)

GENERAL PHYSICAL ARTICLES

2124. A Simplification of Maxwell's Equations in Conformity with the Flux-Cutting Principle.—Drysdale. (*Nature*, 5th Feb. 1938, Vol. 141, pp. 254–256.)

2125. A New Method for the Precision Determination of e/m for Electrons [using Focusing Properties of Crossed Electric and Magnetic Fields with Circular Orbits].—Shaw. (*Phys. Review*, 15th Jan. 1938, Series 2, Vol. 53, No. 2, p. 208 : abstract only.)

2126. The Effect of Cathode Material on the Second Townsend Coefficient for Ionisation by Collision in Pure & Contaminated N_2 Gas.—Bowls. (*Phys. Review*, 15th Feb. 1938, Vol. 53, No. 4, pp. 293–301.)

2127. A Thermodynamical Calculation of Ionisation [of Gases on Assumption of Quiescent Nuclei].—Riewe. (*Zeitschr. f. Physik*, No. 9/10, Vol. 107, 1937, pp. 680–682.)

2128. Ionisation of Mercury Atoms as a Function of the Bombarding Electron Energy.—Nottingham. (*Phys. Review*, 15th Feb. 1938, Vol. 53, No. 4, p. 328 : abstract only.)

2129. Van der Waals Forces between Symmetrical Rotators [Polyatomic Molecules which are representable as Symmetrical Tops].—Carroll. (*Phys. Review*, 15th Feb. 1938, Vol. 53, No. 4, pp. 310–312.)

2130. Wave Functions and Permeabilities for a New Type of Potential Barrier.—Bell. (*See* 1992.)

2131. On the Deviations from Ohm's Law at High Current Densities [Wave-Mechanical Calculations show One per Cent Deviation only possible near 10^8 amp/cm^2].—Guth & Mayerhöfer. (*Phys. Review*, 15th Jan. 1938, Series 2, Vol. 53, No. 2, p. 205 : abstract only.)

MISCELLANEOUS

2132. The Impedance Concept and Its Application to Problems of Reflection, Refraction, Shielding, and Power Absorption.—Schelkunoff. (*See* 1740.)

2133. Potential Coefficients : Their Application to the Solution of Electrical Engineering Problems [Capacity Calculation, Shelding, Transmission Line Protection, etc.].—Cotton & Simmonds. (*Electrician*, 25th Feb. 1938, Vol. 120, pp. 229–231.)

2134. On Fractional Differentials [Half-Differential Quotients of Well-Known Functions in Curve Form : Main Features of Fractional Differential Quotients : Application to Current and Voltage at Origin of Infinite Cable, and Other Physical Problems].—Gemant. (*Phil. Mag.*, March 1938, Series 7, Vol. 25, No. 168, pp. 540–549.)

2135. Relaxation Methods applied to Engineering Problems [involving Systems of Linear Simultaneous Equations].—Black & Southwell. (*See* 1809.)

2136. The Representation of Periodic Functions, in Particular by " Path Curves."—Jordan. (*E.N.T.*, Jan. 1938, Vol. 15, No. 1, pp. 18–25.)

By a " path curve " (" Bahnkurve ") is meant a curve which allows a periodic function to be regarded as the form, spread along the time axis, of the motion of the projection on an axis of a point moving round the curve, as the sine function is the motion of the projection on a diameter of a point moving uniformly round a circle. Here, non-sinusoidal periodic motions are considered ; the conditions for their representation by uniformly moving vectors are discussed and illustrated by examples. § II gives the underlying mathematical ideas of the connection between path curves and oscillation curves and the derivation of oscillation curves from arbitrarily chosen path curves, such as ovals ; and conversely, the conditions under which the path curves corresponding to given oscillation curves can be deduced. Fig. 5 gives oscillation curves corresponding to a circular path curve for various positions of the path origin (*i.e.* the centre of projection of the motion) ; Figs. 6–8 show path curves corresponding to sinusoidal motion under various projection conditions. Examples are given in § III, in particular the use of the ellipse as a path curve for a rectangular wave (Figs. 9–12), the lemniscate (Fig. 13) and an elliptic function (Fig. 14) as path curves.

2137. On the Operational Representation of M-Functions of the Confluent Hypergeometric Type, *and* On Whittaker's Confluent Hypergeometric Function [New Properties].—Dhar : Sharma. (*Phil. Mag.*, March 1938, Series 7, Vol. 25, No. 168, pp. 416–425 : pp. 491–504.)

2138. Moment Recurrence Relations for Binomial, Poisson, and Hypergeometric Frequency Distributions.—Riordan. (*Bell S. Tech. Journ.*, Jan. 1938, Vol. 17, No. 1, pp. 187–188 : summary only.)

2139. Theory of Loci [Construction of Conic Sections and Bicircular Quartics from Straight Lines and Circles].—Leiner. (*Arch. f. Elektrot.*, 17th Jan. 1938, Vol. 32, No. 1, pp. 52–58.)

2140. The Numerical Solution of Laplace's Equation [Rapidly Convergent Iterative Procedure].—Shortley & Weller. (*Phys. Review*, 15th Jan. 1938, Series 2, Vol. 53, No. 2, p. 207 : abstract only.)

2141. Integral Representations for Products of Weber's Parabolic Cylinder Functions.—Howell. (*Phil. Mag.*, March 1938, Series 7, Vol. 25, No. 168, pp. 456–458.)

2142. " Bessel Functions : Part I " [Book Review].—(*Electrician*, 25th Feb. 1938, Vol. 120, p. 236.)

2143. " Höhere Mathematik für den Praktiker " [Book Review].—Lorentz : Joos : Kaluza. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 19, 1938, p. 52.)

2144. " Progress in Physics : Vol. IV " [Book Review]. — Ferguson (Edited by). (*Electrician*, 25th Feb. 1938, Vol. 120, p. 236.)

2145. Micro-Wave Demonstration Equipment.—Bourdeaux & Clarke. (*P.O. Elec. Eng. Journ.*, Jan. 1938, Vol. 30, Part 4, pp. 313–319.)

2146. Science on the Radio : or What are We to Do for 8.5×10^7 Listeners ?—Lemon. (*Review Scient. Instr.*, March 1938, Vol. 9, No. 3, pp. 75–78.)

2147. Some Comments on the Work of the International Electrotechnical Commission.—Zilitinkevich. (*Izvestiya Elektroprom. Slab. Toka*, No. 1, 1938, pp. 21–24.)

2148. Activities of the Italian Research Council : Radio Engineering.—(*La Ricerca Scient.*, 15th/31st Jan. 1938, Series 2, 9th Year, Vol. 1, No. 1/2, pp. 49–51.)

2149. Research in Canada [including Economics of Research: Research in Russia—a Comparison with Canada].—McNaughton. (*Journ. Inst. Eng. Australia*, Jan. 1938, Vol. 10, No. 1, pp. 31–39.)

2150. Progress in Engineering Knowledge during 1937.—Alger. (*Gen. Elec. Review*, Feb. 1938, Vol. 41, No. 2, pp. 72–88.)

2151. Electrical Communication in 1937.—(*Elec. Communication*, Jan. 1938, Vol. 16, No. 3, pp. 185–204.)

2152. "Abstracts of Papers published in the Year 1936" [Book Notice].—Nat. Physical Laboratory. (*Wireless Engineer*, Feb. 1938, Vol. 15, No. 2, p. 92.)

2153. "VDE-Fachberichte 1937: Vol. 9" [Book Review].—Verband Deutscher Elektrotechniker. (*E.T.Z.*, 17th Feb. 1938, Vol. 59, No. 7, p. 184.) *See* also 383 of January.

2154. "The Radio Amateur's Handbook, 1938" [Book Review].—(*Communications*, Feb. 1938, Vol. 18, No. 2, pp. 32–33.)

2155. "Dictionary of Radio Terminology in the English, German, French, and Russian Languages" [Book Review].—Litvinenko. (*Wireless Engineer*, Feb. 1938, Vol. 15, No. 2, pp. 91–92.)

2156. "Anglo-Russkiy Radioslovar" [Radio Dictionary].—Shevtsov & others. (At Patent Office Library, London: Cat. No. 78 335.)

2157. Electrical Studies of Living Tissue: II—Correlation between Tissue Response and Voltage Distribution.—Conrad, Haggard, & Teare. (*Elec. Engineering*, Jan. 1938, Vol. 57, No. 1, Supp. pp. 1–4.) For I *see* 778 of 1937.

2158. Human Relay System [Recent Discoveries on Electrical Impulses along Nerves: Measuring Methods and Apparatus at Royal College of Surgeons].—Parr. (*Wireless World*, 10th March 1938, Vol. 42, pp. 218–219.)

2159. The Drying of Wood by Radio [Russian Work on Ultra-Short, Short, and Medium Waves: Particularly Good Recent Results (Improved Mechanical Properties) with 500–1500 m Waves.]—Beaupré. (*Technique*, Montreal, Jan. 1938, Vol. 13, No. 1, p. 46: in French.) *See* also 4294 of 1936.

60. The Modulator Bridge ["Ring Modulator"] in Industrial Applications such as Humidity Measurement.—Hellmann. (*See* 1839.)

2161. A Carrier Telephone System for Toll Cables; *also* Cable Carrier Telephone Terminals; Crystal Channel Filters for the Cable Carrier System; Crosstalk and Noise Features of Cable Carrier Telephone System; *and* A New Single-Channel Carrier Telephone System.—Green, Chestnut, Lane, & others. (*Bell S. Tech. Journ.*, Jan. 1938, Vol. 17, No. 1, pp. 80–183.)

2162. A Carrier-Current Telemeter [Impulse-Current Method with Photocell].—Jimbo & Ito. (*Electrot. Journ.*, Tokyo, Feb. 1938, Vol. 2, No. 2, pp. 32–35.)

2163. The Production of Large Single Crystals of Potassium Bromide suitable for Optical Use [for Infra-Red Work], *and* The Commercial Production of Large Single Crystals of Lithium Fluoride.—Stockbarger: Harshaw Chem. Company. (*Journ. Opt. Soc. Am.*, Dec. 1937, Vol. 27, No. 12, pp. 416–419: *Journ. Scient. Instr.*, March 1938, Vol. 15, No. 3, p. 111.)

2164. A Light Source of Uniform Energy in the Region of Visible Wavelengths [for Photometry, etc.]—von Ardenne. (*See* 1959.)

2165. An Instrument to Study the Intensity Variation of Transient Light Pulses [using C-R Oscillograph with Long-Persistence Screen: for Investigation of Photographic Shutters and Flash Lamps].—Kelley. (*Journ. Opt. Soc. Am.*, Jan. 1938, Vol. 28, No. 1, pp. 27–29.)

2166. Rapid and Accurate Measurement of Line Positions on X-Ray Diffraction Films with the Aid of a Cathode-Ray Oscillograph [controlled by Photocell].—Tatel & Hultgren. (*Review Scient. Instr.*, Feb. 1938, Vol. 9, No. 2, pp. 47–50.)

2167. A Photoelectric Transmission Spectrophotometer for the Measurement of Photosensitive Solutions.—Shlaer. (*Journ. Opt. Soc. Am.*, Jan. 1938, Vol. 28, No. 1, pp. 18–22.)

2168. Chromaticity Limitations of the Best Physically Realisable Three-Filter Photoelectric Colorimeter.—Van den Akker. (*Journ. Opt. Soc. Am.*, Dec. 1937, Vol. 27, No. 12, pp. 401–407.)

2169. Precision and Accuracy of Apparent Reflectance Measurements with a Photoelectric Illumination Meter, *and* Development of Filters for Tri-Stimulus and Luminosity Measurements with Barrier-Layer Photocells.—Hunter. (*Journ. of Opt. Soc. Am.*, Feb. 1938, Vol. 28, No. 2, p. 51: pp. 51–52: summaries only.)

2170. A New Portable Photoelectric Illumination Meter.—Preston. (*Journ. Scient. Instr.*, March 1938, Vol. 15, No. 3, pp. 102–105.)

2171. Papers on Selenium Photovoltaic Cells.—Elvegård & others. (*See* 1984 & 1985.)

2172. Photocell Experience in the Factory [Troubles with Stray Light, Insulation (including Fungus Trouble), and Power Supply].—Edelmann. (*Electronics*, March 1938, Vol. 11, No. 3, pp. 15–16.)

2173. Photoelectric Flour Tester [determining Percentage of Bran to 0.2%].—Puzrin. (*Electronics*, Feb. 1938, Vol. 11, No. 2, p. 47: photograph only.)

Some Recent Patents

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

ACOUSTICS AND AUDIO-FREQUENCY CIRCUITS AND APPARATUS

477 566.—Radiogram in which the pick-up voltage is applied between the suppressor grid and cathode of a pentode valve acting as a leaky-grid detector.

E. K. Cole and H. A. Brooke. Application date 3rd October, 1936.

478 436.—Low-frequency amplifier provided with automatic gain control means for " expanding " the dynamic range of the reproduced signals.

A. H. Stevens (communicated by Newtone Engineering Inc.). Application date 22nd July, 1936.

479 440.—Feed-back circuit used on the L.F. side of a receiver to improve the action of the rectifier, to control amplification, and to prevent distortion.

G. W. Johnson (communicated by Philco Radio and Television Corpn.). Application date 4th August, 1936.

AERIALS AND AERIAL SYSTEMS

477 914.—Arrangement for matching the impedance of a half-wave aerial, suitable for transmitting television signals, to that of a coaxial feed-line.

E. C. Cork and J. T. Pawsey. Application date 10th July, 1936.

478 211.—Balancing and matching the impedance of a high-frequency transmission line to that of an aerial or other load.

Marconi's W.T. Co. (assignees of P. S. Carter). Convention dates (U.S.A.) 13th and 17th July, 1935.

480 434.—Method of matching the impedance of a transmission line to a reactive load, particularly a short-wave aerial, over a wide range of signalling frequencies.

E. C. Cork and J. L. Pawsey. Application date 18th June, 1936.

DIRECTIONAL WIRELESS

477 963.—Radiogoniometer arranged to show the minimum of the cardioid curve in the same line as the distant transmitter instead of being displaced by the usual 90°.

Panstwowe Zaklady Tele-Radjotechniczne W. Warszawie. Convention date (Poland) 10th July, 1935.

478 395.—Radiogoniometer for direction finding with means for correcting quadrantal and octantal error.

C. Lorenz Akt. Convention dates (Germany) 24th January and 24th September, 1936.

478 470.—Directive aerial system for radiating a navigational beam for guiding an aeroplane to its landing point.

Standard Telephones and Cables (assignees of Le Materiel Telephonique Soc. Anon. Convention date (France) 9th April, 1936.

479 330.—Directional aerial with adjustable mounting to compensate for errors due to an asymmetrical earth.

C. Lorenz Akt. Convention date (Germany) 18th July, 1936.

RECEIVING CIRCUITS AND APPARATUS

(*See also under Television*)

477 370.—Combination of broad band-pass and narrow band-pass amplifiers with a pentode valve operating as a " limiter " for cutting out static interference.

Marconi's W.T. Co. Convention date (U.S.A.) 29th June, 1935.

477 503.—Automatic timing device for stopping and starting a wireless receiver.

D. Fisher. Application date 30th March, 1937.

477 808.—Cutting-out interference due to the rotating propeller when receiving wireless signals on an aeroplane.

C. Lorenz Akt. Convention date (Germany) 30th April, 1936.

477 815.—Intervalve coupling including a screened-grid " buffer " valve to minimise the capacity losses when handling high frequencies.

P. W. Willans; A. J. Brown; and Baird Television. Application date 7th July, 1936.

477 890.—Transmission line designed to give substantially uniform amplification over a wide band of frequencies fed from an aerial to a number of remotely situated broadcast receivers.

F. R. W. Strafford and Belling and Lee. Application date 3rd July, 1936.

478 015.—Stabilised reaction circuit for the mixing or frequency-changing stage of a superhet receiver.

E. P. Rudkin. Application date 11th September, 1936.

478 148.—Means for facilitating the correct alignment of the pointer with a desired marking on the tuning indicator of a wireless set.

Radiowerk Horny A.G. Convention date (Austria) 1st February, 1936.

478 194.—Means for preventing frequency drift in a single-valve " mixer " or frequency-changer as used in a superhet receiver.

R. I. Kinross and W. J. Brown. Application date 13th June, 1936.

478 226.—Automatic selectivity control in which the effective width of a band-pass circuit is varied by an auxiliary valve in accordance with the amplitude of the received signals.

Hazeltine Corpn. (assignees of J. F. Farrington). Convention date (U.S.A.) 12th February, 1936.

478 272.—Utilising a thermionic valve to reduce the effective capacity of a circuit to which it is coupled.

Standard Telephones and Cables and W. T. Gibson. Application date 17th July, 1936.

478 356.—Arrangement of the "error-detecting" circuit used for automatic tuning control in a superhet set.

Murphy Radio and H. D. Ellis. Application date 17th June, 1936.

478 392.—Construction of multi-way switches particularly for wave-change control in a wireless receiver.

Oak Manufacturing Co. (assignees of K. C. Allison and E. J. Mastney). Convention date (U.S.A.) 8th September, 1936.

478 581.—Method of mounting H.F. coils so as to control their variable coupling, particularly between an aerial and the input stage of a wireless receiver.

Telefunken Co. Convention date (Germany) 19th July, 1935.

478 584.—Automatic volume control system for handling a wide range of input amplitudes, particularly for "mobile" receivers liable to operate under wide variations in signal field-strength.

Johnson Laboratories Inc. (assignees of A. Crossley and H. E. Meinema). Convention date (U.S.A.) 25th July, 1935.

478 734.—Split-band amplifier for handling a wide band of frequencies and eliminating "mush," such as the Schrott effect, Johnson noise, and needle scratch.

W. S. Percival. Application date 20th May, 1936.

478 775.—Automatic tuning control in which the effect of "phase shift," at and away from resonance, is utilised to secure the required adjustment.

Marconi's W.T. Co. (assignees of G. Guanella and M. Lattmann (addition to 472 739). Convention date (Switzerland) 14th September, 1936.

TELEVISION CIRCUITS AND APPARATUS

For Transmission and Reception

477 363.—Optical projection system for enlarging the picture produced on the fluorescent screen of a cathode-ray television receiver.

Telefunken Co. Convention date (Germany) 26th July, 1935.

477 377.—Generating the frame and line synchronising signals used in television.

Philco Radio and Television Corpn. Convention date (U.S.A.) 17th June, 1935.

477 397.—Separating the synchronising impulses from the picture signals in a television receiver.

Baird Television and L. R. Merdler. Application date 25th May, 1936.

477 406.—Optical system for projecting the light from both sides of a fluorescent screen on to an external viewing-screen.

Baird Television; C. Szegho; and G. A. R. Tomes. Application date 26th June, 1936.

477 433.—Timing circuit for a television receiver in which means are provided for preventing the spot from burning the fluorescent screen during non-scanning periods.

Philco Radio and Television Corpn. Convention date (U.S.A.) 7th June, 1935.

477 539.—Magnetic deflecting means for the electron stream of a cathode-ray tube.

Baird Television and A. H. Gilbert. Application date 2nd July, 1936.

477 540.—Interlaced scanning system in which a low-frequency synchronising impulse is transmitted only at the end of each traversal of the picture instead of at an intermediate point on the traverse.

Baird Television and P. W. Willans. Application date 2nd July, 1936.

477 561.—Scanning system for television in which use is made of a photo-sensitive cell having a characteristic with a sharp upper bend to distinguish between the picture elements and a maximum level of illumination.

E. Michaelis. Convention date (Germany) 20th July, 1935.

477 604.—Scanning system in which the signals are passed through a light-cell which is traversed by a train of mechanical vibrations of supersonic frequency, the image projected on the screen being immobolised by an oscillating mirror.

Scophony and F. von Okolicsanyi. Application date 28th April, 1936.

477 612.—Cathode-ray "projector" in which the televised image is reproduced by the incandescence of a screen of highly refractory sheet material which takes the place of the usual fluorescent screen.

N. V. Philips' Lamp Co. Convention date (Holland) 20th July, 1935.

477 765.—Television scanning system specially designed to prevent any interaction between the line deflecting circuit and the frame deflecting circuit.

Marconi's W.T. Co. (assignees of W. J. Poch). Convention date (U.S.A.) 31st May, 1935.

477 775.—Television system utilising infra-red rays to project scenes normally invisible owing to fog.

Sturdy-Cage Projects Inc. Convention date U.S.A.) 6th July, 1935.

477 814.—Television receiver cabinet fitted with a cap-shaped lens and a curved viewing screen to offset the distortion due to the curvature of the cathode-ray bulb.

E. Michaelis. Convention date (Germany) 12th June, 1936.

477 864.—Television receiver in which the scanning voltages are generated by a relaxation oscillation generator, which is only made sensitive when the synchronising signals arrive.

P. M. G. Toulon. Convention date (France) 27th November, 1935.

477 897.—Time-base circuit for a television receiver in which a de-coupling circuit isolates the line-scanning from the frame-scanning oscillator.

Baird Television and A. H. Gilbert. Application date 8th July, 1936.

477 906.—Automatically compensating for the detuning of a television receiver due to "Miller effect."

Baird Television and L. R. Merdler. Application date 9th July, 1936.

478 083.—Arrangement and assembly of the external magnetic winding used for focusing the electron stream of a cathode-ray tube.

Ferranti and E. G. O. Anderson. Application date 5th October, 1936.

478 095.—Output coupling for an electron amplifier of the cathode-ray type, particularly for ultra-short waves.

Telefunken Co. Convention date (Germany) 4th March, 1936.

478 121.—Cathode-ray tube fitted with a screen which is partly fluorescent and partly photo-sensitive so that the tube can be used either as a television receiver or transmitter.

V. Zeitline; A. Zeitline; and V. Kliatchko. Convention date (France) 9th May, 1935.

478 133.—Projection lamp particularly designed for use with a television transmitter.

Radio-Akt D. S. Loewe. Convention date (Germany) 12th July, 1935.

478 151.—Scanning system for television in which the negative polarity of the synchronising signal relatively to the picture signals is applied to trigger the local oscillator without separating the two sets of signals.

Cie pour la Fabrication des Compteurs et Materiel d'usines à gaz. Convention date (France) 14th November, 1935.

478 153.—Potentiometer circuit for supplying graded biasing voltages to the various electrodes of an electron-multiplier utilising secondary emission.

The General Electric Co. and D. C. Espley. Application date 13th November, 1936.

478 200.—Controlling the electron stream in a cathode-ray tube so as to ensure a uniform overall "luminosity" of the pattern produced on the sensitive screen.

Westinghouse Electric and Manufacturing Co. (assignees of L. E. Swedlund). Convention date (U.S.A.) 24th August, 1935.

478 238.—Light-sensitive device with a reaction coupling between a fluorescent screen and a photo-sensitive electrode.

V. Zeitline; A. Zeitline; and V. Kliatchko. Convention date (France) 13th June, 1935.

478 260.—Arrangement and assembly of the external magnetic deflecting coils of a cathode-ray tube.

Fernseh Akt. Convention date (Germany) 16th July, 1935.

478 266.—Construction of electro-magnetic deflecting coils for mounting inside the glass bulb of a cathode-ray tube.

E. Ruska and Fernseh Akt. Application date 17th July, 1936.

478 300.—Valve oscillation-generator for stepping-up the voltage from D.C. mains to supply a television receiver.

E. Michaelis. Application date 11th July, 1936.

478 410.—Cathode-ray tube with internal focusing and control electrodes consisting of permanent magnets.

Zeiss Ikon Akt. Convention date (Germany) 28th May, 1936.

479 318.—Coustruction of screen for a cathode-ray tube in which television pictures are produced by incandescence.

Farnsworth Television Inc. Convention date (U.S.A.) 9th March, 1936.

478 426.—Electron discharge tubes in which a photo-sensitive cathode co-operates with a fluorescent screen to produce intensified television signals by secondary emission.

V. Zeitline; A. Zeitline; and V. Kliatchko. Convention date (France) 30th July, 1935.

478 475.—Electrode system for a cathode-ray television receiver designed to prevent "fringing" and the so-called "keystone" form of distortion.

Marconi's W.T. Co. (assignees of J. T. Wilson). Convention date (U.S.A.) 12th May, 1936.

478 499.—Cathode-ray television transmitter in which the electrons emitted from a photo-sensitive screen are "stored" upon a screen comprising fluorescent material, from which they are discharged by a scanning beam.

V. Zeitline; A. Zeitline; and V. Kliatchko. Convention date (France) 18th May, 1935.

478 511.—Time-base circuit for television in which saw-toothed scanning voltages are produced in push-pull by means of a relaxation oscillator.

C. L. Faudell. Application date 17th July, 1936.

478 971.—Fluorescent screen for a cathode-ray tube mounted on a mesh-work "backing" which is transparent to light.

Marconi's W.T. Co. and G. F. Brett. Application date 27th July, 1936.

479 421. — Intermediate - frequency amplifier designed to give a straight-line response over a wide frequency range, particularly for television.

E. Michaelis. Convention date (Germany) 28th August, 1936.

TRANSMITTING CIRCUITS AND APPARATUS

(See also under Television)

477 450.—Wired system for transmitting either "straight" or "stereophonic" programmes as desired.

Wired Radio Inc. Convention date (U.S.A.) 11th February, 1936.

477 497.—Wired wireless carrier-wave system for multiplex working.

Standard Telephones and Cables (assignees of W. H. Tidd). Convention date (U.S.A.) 12th February, 1936.

477 875.—Generating a group of harmonic frequencies, for multiplex transmission systems, from a single or basic wave.

Standard Telephones and Cables (assignees of L. R. Wrathall). Convention date (U.S.A.) 5th May, 1936.

477 912.—Generating a carrier-wave of constant frequency derived by heterodyning two oscillations produced from temperature-compensated circuits.

C. Lorenz, Akt. Convention date (Germany) 17th July, 1935.

478 137.—Means for automatically compressing the volume-range in broadcast transmission and for automatically expanding the signals at the receiving end.

E. L. E. Pawley. Application date 10th July, 1936.

478 314.—Method of generating H.F. currents and superposing them on A.C. power mains.

E. Hallowell and Northern Utilities Trust. Application date 14th July, 1936.

478 462.—Short-wave valve coupling for connecting two sections of a transmission line of the so-called "dielectric guide" type.

Standard Telephones and Cables (communicated by Western Electric Co. Inc.). Application date 1st March, 1937.

478 474.—Short-wave high-powered generator consisting of a number of oscillators coupled in parallel to a common output circuit.

Marconi's W.T. Co. (assignees of P.D. Zottu). Convention date (U.S.A.) 22nd April, 1936.

478 552.—Push-pull system of modulation designed to increase efficiency for a given power-consumption.

J. J. Pohjanpalo. Application date 3rd April, 1937.

478 849.—Method of reducing the self-capacity of a valve system for generating ultra-short waves at high power.

Telefunken Co. Convention date (Germany) 30th November, 1935.

479 034.—Keying a high-powered radio transmitter by controlling the grid bias of one or more of the amplifier stages.

Standard Telephones and Cables (communicated by Western Electric Co. Inc.). Application date 28th July, 1936.

480 052.—Split-anode type of magnetron oscillator designed to generate very short waves at high power.

Telefunken Co. Convention date (Germany) 24th February, 1936.

480 219.—Carrier current transmission systems for indicating abnormal circuit conditions and giving similar alarm warnings.

Standard Telephones and Cables (assignees of C. B. Sutliff). Convention date (U.S.A.) 10th April, 1936.

CONSTRUCTION OF ELECTRONIC-DISHARGE DEVICES

477 637.—Method of manufacturing indirectly heated cathodes from tungsten coated with a suspension of alumina containing a calcium salt.

The M-O Valve Co. and M. Benjamin. Application date 6th October, 1936.

477 648.—Electrode arrangement for an amplifier utilising secondary emission.

The General Electric Co. and W. H. Aldous. Application date 10th November, 1936.

477 668.—Electrode arrangement for a discharge tube of the cathode-ray type, designed for generating or amplifying very short waves.

Telefunken Co. Convention dates (Germany) 4th March and 6th and 14th April, 1936.

477 669.—Assembling and centering the electrodes of a discharge tube for handling centimetre waves.

C. Lorenz Akt. Convention dates (Germany) 16th March and 5th November, 1936.

477 672.—Electrode arrangement for an ultra-short wave valve in which the discharge stream passing through the valve is bent back on itself, so as to pass twice through the same control or deflecting field.

Telefunken Co. Convention date (Germany) 8th April, 1936.

477 767.—Process for producing oxide-coated or so-called "painted" cathodes.

Egyesult Izzolampa es Villa Mossagi. Convention date (Hungary) 5th June, 1935.

477 787.—Arrangement and method of assembling the electrodes, particularly the heating-filament and cathode, of a thermionic valve.

Egyesult Izzolampa es Villa Mossagi. Convention date (Hungary) 31st August, 1935.

477 850.—Electrode arrangement for a valve of the type in which the electron stream is deliberately broken up into discrete jets.

Marconi's W.T. Co. (assignees of H. C. Thompson). Convention date (U.S.A.) 5th July, 1935.

477 874.—Method of producing the aperture in the anode of a cathode ray tube by utilising the burning action of the electron stream.

Farnsworth Television Inc. Convention date (U.S.A.) 18th May, 1936.

478 001.—Electron multiplier in which one or both of the cathodes consists of a metal disc coated with lithium borate sensitised by a radio-active salt of uranium.

Marconi's W.T. Co. and G. B. Banks. Application date 13th July, 1936.

478 166.—Electrode arrangement of a magnetron discharge tube of the split-anode type for handling ultra-short waves.

Telefunken Co. Convention date (Germany) 30th April, 1936.

478 262.—Arrangement and assembly of the electrode system in an electron multiplier using secondary emission.

The General Electric Co.; W. H. Aldous; D. W. Fry; and C. H. Simms. Application date 16th July, 1936.

478 813.—Secondary emission amplifiers in which the internal electrodes or "targets" are so arranged as to reduce the number of external electrodes and to allow comparatively low operating potentials to be used.

Marconi's W.T. Co. and G. B. Banks. Application date 25th June, 1936.

SUBSIDIARY APPARATUS AND MATERIALS

477 531.—Construction of dry-contact rectifier units with provision for cooling.

S. A. Stevens; L. E. Thompson; and Westinghouse Brake and Signal Co. Application date 1st July, 1936.

477 623.—Piezo-electric crystal rectifier which directly resonates to voice or musical frequencies.

Standard Telephones and Cables (assignees of S. C. Hight). Convention date (U.S.A.) 1st August, 1935.

477 916.—Light cell in which the primary electrons emitted from the photo-sensitive cathode are augmented by secondary emission.

Radio Akt D. S. Loewe. Convention date (Germany) 11th July, 1935.

478 302.—Method of producing a fluorescent screen capable of emitting light of longer wavelength than usual.

Telefunken Co. Convention date (Germany) 11th July, 1935.

478 483.—Resilient clamp or holder for mounting piezo-electric crystals, so as to reduce bending strains, particularly in a wave filter circuit.

Standard Telephones and Cables (assignees of W. G. Laskey). Convention date (U.S.A.) 12th June, 1936.